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ARMAMENT SYSTEMS, INC.

2 April 1986

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SUBJECT: Task Order #7, Contract DAAK11-84-D-0004

TO: Director
US Army Laboratory Command
Human Engineering Laboratory
ATTN: SLCHE-CSSD(Mr. John Stephens)
Aberdeen Proving Ground, MD 21005-5001

Dear Mr. Stephens:

Enclosed are two copies of the Final Report, ASI 86-02, entitled "Field Materiel Handling Robot Workcell". Included are the original of all photographs and sketches.

Appendix E to the report includes photographs of ammunition containers discussed in the report. Photographs for two of the containers were not available from any Government or commercial source. The containers in question will be photographed at Eglin AF Base and inserted in the report upon receipt.

The submission of this report completes all action required in Task Order #7, Contract DAAK11-84-D-0004.

It has been a pleasure working with you on this important facet of future ammunition logistics.

Sincerely,

B. M. DAVALL
Vice President

BMD/amc

Enclosure: A/S

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Open-Sided Container	ISO Containers	Field Materiel Handling Robot(FMR

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Practically all of the international maritime shipping of the world's goods and products, with the exception of bulk grain, raw materials (iron ore, etc.), and POL, are shipped via International Standardization Organization (ISO) containers. The bulk of today's shipping vessels are either container ships or ships converted for handling of containers. Almost all of the world's major shipping ports are equipped with gantry cranes for the on-loading and off-loading of containers. It is therefore obvious that the use of containers for the overseas

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shipment of military items will be an important consideration in all future military logistics plans and operations. Since ammunition is one of the most, if not the most, critical military commodities in time of war, there is a need to determine the availability of ISO containers suitable for the shipment of ammunition. Because of the limited availability of MILVANS, their supply is forecasted to be exhausted during the first week of mobilization. Although the trend in the shipping container industry is away from 20 ft containers and towards the 40 ft long container, adequate quantities of the 20 ft containers are forecast to be available for shipment of ammunition at least until the year 2000 and perhaps longer.

Alternative configurations are presented for the Field Materiel Handling Robot (FMR) workcell for unloading the 20 ft MILVAN and the 20 ft ISO containers.

Time, labor, and material currently required for the emplacement of dunnage in containerized ammunition suggests an urgent need to find a better way of restraining containerized ammunition. Alternatives include plastic and metal fabricated reusable dunnage, air bags, foamed-in-place dunnage, as well as selected commercial container restraint systems such as the PALLA-GARD system.

ASI 86-02

FIELD MATERIEL HANDLING ROBOT WORKCELL

Contract Number: DAAK11-84-D-0004
Task Order Number 7

FINAL REPORT
March 1986

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ACKNOWLEDGEMENTS

This report documents a project performed under Contract DAAK11-84-D-0004 for the US Army Human Engineering Laboratory, Aberdeen Proving Ground, Maryland. We wish to express our appreciation to Mr. Salser for his help and guidance on this project.

Further, we wish to express our appreciation for the information and assistance we received from those individuals listed as Points-of-Contact at Appendix D of this report, especially Mr. Willis of the US Army Defense Ammunition Center and School, Savanna, Illinois, who provided invaluable data regarding container hardware and testing throughout the Services.

Finally, we appreciate the efforts of Mrs. Allie M. Cullen and Ms. Dianne Vaughn who typed and assembled the various segments of the report.

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INTRODUCTION

This report is in response to an urgent need expressed by the US Army Human Engineering Laboratory (HEL) to investigate trends and peacetime practices in the use of commercial shipping containers of the International Standardization Organization (ISO) or Military Van (MILVAN) type. This study addresses: the leasing of containers by the military; the generation of costs to the intermodal shipper; the potential availability of side opening containers and other containers which may be used for the shipping of ammunition; manual and automated tracking of containers enroute; container design information; dunnage, stuffing and unstuffing of containers; the impact of container unloading operations at the in-theater terminus of the transportation chain; and the retrograding of containers (e.g., deadheading of empties versus candidate return loads). Based on an analysis of the above, alternative configurations for the Field Materiel Handling Robot (FMR) workcells and the impact of such alternate configurations on flow rates and operating envelope and characteristics are provided.

BACKGROUND

The use of reusable containers for the shipment of goods and materials can be traced back to the early days of the railroads when containers were used for transporting everything from precious metals to valuable documents to fine furniture to all types of machinery and equipment. For the most part, these containers were all specially designed to meet the needs of a particular commodity or product.

The general use of multi-product standard containers did not enter the world shipping scene until the 1950's when the United States Lines, headed by Sea-Land pioneer Malcom McLean, took their truck bodies to sea rather than have them towed individually across America.

It was not until 1984 with the introduction of the round-the-world shipping services, that used the very large vessels, that the containers began to dominate the shipping scene.

As of mid-1985, there were 106 container manufacturers, 82 container lessors, 118 container handling equipment manufacturers, and 280 container repair companies. There are almost 500 operators, over 250 of which are ocean-going companies. In addition, there are another 142 component suppliers who provide equipment and services for stuffing and unstuffing containers.[1]

The prosperity of the container industry is finely balanced on international trade. Post-1983 saw the industry move out of a recession which was caused largely by the strength of the dollar and the picking up of the US economy. Protectionist measures such as import surcharges, may result in reduced imports/exports of many nations, and present a rather bleak future for the container industry. Nothwithstanding the above, it is apparent that the use of containers for the overseas shipment of military items will be an important consideration in all future military logistics plans and operations. As an example, at the present time, approximately 80% of all ammunition being shipped to Europe is transported in MILVAN and ISO type containers.

OBJECTIVE

The objective of this study is to provide trends and peacetime practices in the use of commercial shipping containers of the ISO/MILVAN type, to determine the suitability of these containers for the shipping of ammunition and their impact on the unloading operations at the in-theater terminus of the transportation chain, and to provide alternative workcell arrangements as may be required in support of the FMR demonstration.

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[1] Jane's Freight Containers, Jane's Publishing, Inc., New York, 1985

METHODOLOGY

The first step in the conduct of the study was to perform a literature search of military and military related studies of containers and associated subjects such as container handling equipment, container stuffing and unstuffing, dunnage, and container testing. This literature search was then expanded to include the review of technical periodicals; commercial publications from the private sector such as the "Intermodal Container News", a monthly publication; "Jane's Freight Containers"; and assorted literature from container manufacturers and container handling equipment manufacturers.

Step two involved telephone conversations with designated points of contact (POCs) for containers within each of the military services, and follow-up letters with questionnaires to obtain specific information and results of earlier container studies, experimental tests of container operations, and other container activities within each of the Services.

Telephone and questionnaire information provided by the Service POCs did not necessarily result in information that indicated any revolutionary of drastic changes in ammunition container design or configuration. Most of the useful information was obtained from US Army and Air Force sources. The US Navy responses (Naval Sea Systems Command, Naval Supply Systems Command and the Naval Facilities Engineering Command) indicated that the Navy "is not in the business of ammunition container development". The US Marine Corps' ammunition container requirements are fulfilled through the US Army's efforts or is leased from commercial sources. The Marine Corps' Container System of the Field Logistics System, except for flatracks, is not intended for ammunition storage or shipment.

Therefore, the preponderance of ammunition container information contained herein was provided the US Army and the US Air Force. Specific agency sources are identified with the information.

As a means of complementing this baseline information, step three included visits to the Maryland Port Administration, major intermodal shipping companies, a container packaging company, and the International Terminal Operating Company, Inc. (ITO). Discussion included top level officials, middle managers, supervisors and workers. Container stuffing and unstuffing operations and ship loading and unloading were observed. Preprinted questionnaires and/or topic outlines were forwarded to organizations prior to the scheduled visit. This methodology proved to be very effective in that the persons visited were able to collect some of the information needed and have it available at the time of our visit. Experts capable of responding to the questions were also scheduled to be available at the time of our visit. Both actions significantly facilitated our data collection effort.

The fourth and final step was to perform an analysis of the information obtained and prepare a final report.

DISCUSSION

Trends and Peacetime Practices in the Use of Commercial Shipping Containers

Container Leasing Versus Ownership

The 1985 edition of "Jane's Freight Containers" lists 82 container lessors of which 27 are in the United States and 55 divided among 14 different European, Caribbean and Far East countries.

As of November 1985, the Institute of International Container Lessors (IICL) estimated a total of 1,591,000 Twenty Foot Container Equivalent Units (TEUs)[2] owned by US leasing companies and foreign companies

[2] The TEU is obtained by totalling the container lengths in feet and dividing by 20 feet. One twenty foot container equals one TEU. One forty foot container equals two TEUs or one FEU (Forty Foot Equivalent Unit).

with headquarters in the United States. This compares with approximately 2,400,000 owned by US shipping companies and foreign companies with headquarters in the United States. The world container fleet is projected to be 4,700,000 early in 1986 with an annual production capability of one million TEUs. The US holdings are almost 45% of the world fleet.[3]

Discussions with executives of the Maryland Port Administration, United States Lines and the Sea-Land Corporation (major container shipping lines) revealed that the common practice of the major shipping companies is the purchase or long term (five years) lease of containers. The shipping companies do lease, as needed, special purpose containers such as flatracks, refrigerator containers and others with unique configurations such as open top, open side, etc. Although containers can be leased for as little as thirty days, as a general rule, containers leased by shipping companies are long term, i.e., one to five years, with renewable options for the life of the leased containers. Small and newly created shipping companies are the primary lessors of containers. As these shipping companies grow and mature in size, the tendency is towards the purchase of containers. Representatives of leasing companies, on the other hand, forecast that the container leasing business will continue to grow both in the near term and far term.

Insofar as a customer who has a need for containers to ship a product is concerned, there is no difference between a leased or owned container that is placed at his shipping and receiving warehouse, as many of the leased containers are marked with the name of the shipping company. A company desiring to ship its product to an overseas destination using containers simply contacts one of many shipping companies and orders a predetermined

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(3) Intermodal Equipment Register, Intermodal Publishing Company, Ltd., New York, 1985.

number of containers (on a weekly/monthly basis) which are delivered to the designated point for loading. As the containers are loaded, the shipping company picks up the loaded container either by truck or rail depending on location and, at the same time, provides empty containers to the customer. Although container demurrage charges are estimated to be $0.75 to $3.50 per day, these are normally not imposed on customers who have continuing shipping contracts on a recurring basis unless: containers are held an inordinate long period of time by the customer, the pick-up and drop-off points are out of the way, or special container features are required.(4)

Information provided by the Services regarding the leasing cost of containers varied due to the container source and type of contract. The cost of leasing (by military or civilian) from commercial sources ranges between $3.00 and $5.00. Factors which impact most significantly on the cost are the length of lease, the quantity leased, and provision for maintenance. Lessee costs would be reduced with increased quantities, longer times of leasing, and lessee maintenance. (NOTE: Specific data on MILVAN leasing costs were requested in writing by the COTR from the US Army Armament, Munitions and Chemical Command. The response received did not provide the specific information required for inclusion in this report.)

Container Shipping Costs

The Services let contracts with the various shipping companies for movement of containerized goods. Each bid is broken down in three parts: cost of shipment from the location where the military product is manufactured or stored in a depot to a shipping port, movement from the CONUS port to the OCONUS port closest to final destination of the product, and movement from the OCONUS port to final land point of destination. The Government contract,

(4) Flexi-Van Leasing, Inc., Letter, Lyndhurst, NJ, 26 November 1985.

however, calls for payment of only one consolidated bill from the point of origin to final destination. This includes the CONUS land portion, the lifting of containers from trucks by gantry cranes onto ocean going vessels, the off-loading at the OCONUS port, and the truck or rail movement to final OCONUS point of destination. If the CONUS land portion is by rail to ports where rail cannot be accommodated, the bid price also includes the transfer from the rail cars to trucks and the movement of the container from the railhead to the marine terminal. Although one shipping company may be cheaper for the CONUS land portion of the movement of the product, it may be more expensive in terms of the sea and/or OCONUS land leg of the movement. It is normally the lowest overall bid from point of origin to final point of destination that is accepted by the Government.

Rates vary with the different parts of the country and with the different quantities to be shipped. For example, if the Tobyhanna Army Depot, Pennsylvania, contracts for 400 containers a month for movement from Pennsylvania to Germany, the rate would be cheaper than another depot from the same general location that was shipping only 50 containers per month. Overland prices are quoted generally on the basis of one semitrailer load whether it is one 20-foot container, one 40-foot container, or two 20-foot containers that can be placed on a single flatbed semitrailer. The Tobyhanna Army Depot, which is responsible for the control of all MILVANS, indicated that, on the average, the movement of a container costs approximately $1.10 per land mile in the CONUS. Table 1. is the published lowest bids for carriage of Military Sealift Command cargo from 1 October 1985 to 31 March 1986 for the 8'x8'x40' and the 8'x8'x20' containers.

TABLE 1.

Sample Military Sealift Command Container Cargo Bid Quotations

Low Bid - 6 Months Ending 3/31/86

From the US East Coast to Northern Europe
and the United Kingdom

Company Name	20'Containers	40'Containers
US Lines	$36.12	$16.70
Sea-Land Service	28.79	17.80
TFL	50.00	37.35

From the US West Coast to Destination
in the Far East

Country	Company Name	20'Containers	Company Name	40'Containers
Japan	APL	$15.50	APL	$ 7.88
Korea	APL	22.38	Sea-Land	14.39
Okinawa	Lykes	22.00	Sea-Land	1[illegible] 00
Philippines	APL	27.05	APL	13.12

NOTE: Dollar quotes are measurement ton units (40 cu.ft.), i.e., one 8'x8'x40' container = 59.4 measurement tons - US Lines; one 8'x8'x20' container = 29.08 measurement tons - US Lines.

Based on the above quotations, the cost to ship an 8'x8'x40' container to Northern Europe by US Lines would be $991.98 ($16.70 x 59.4 = $991.98).

The cost to ship a 20'container by the same company to the same destination would be $1050.37 ($36.12 x 29.08 = $1050.37). The cost to ship that same container to the same destination by Sea-Land would be $837.21 ($28.79 x 29.08 - $837.21).

The significant difference in the cost of transporting 40-foot and 20-foot containers is attributable in most part to labor and handling costs. It requires twice as many "picks" and "shifts" with a crane or other MHE if a given amount of cargo, in measurement tons, is transported in <u>two</u> 20-foot containers as opposed to <u>one</u> 40-foot container.

The scope of the study did not provide for the obtaining of detailed comparative costs between break bulk shipments and containerized shipments; however, the question of comparative costs was asked of the Maryland Port Administration, US Lines, Sea-Land, and the ITO. Representatives from all four organizations commented that costs per ton of break bulk cargo versus containerized cargo would be significantly greater for the break bulk cargo due to the increased number of laborers and time and equipment required to handle the break bulk. These same organizations commented further that, in all probability, they would not want to handle break bulk cargo unless it was a national emergency or similar situation. Further discussions on this subject revealed that the only commodities not containerized that are shipped from the majority of US ports are items such as cement mixers or other exceptionally large items that are either too heavy or too bulky to be placed in a container.

Trends in Sizes of Commercial Containers

The early container industry started almost exclusively with the use of 8'x8'x20' containers. Selection of this size container was influenced by the constrained capabilities of the early container lifting and handling equipment as well as the limitations on roads in some of the foreign ports to which containerized shipments were consigned. Some odd sized containers such as 19', 27', and 48' are in the inventory of various shippers; however, they are not considered to be the norm and, therefore, were not given further consideration in this study.

One company, Sea-Land, purchased a large number of 35-foot aluminum skin, steel frame containers (in lieu of 40-foot containers). They indicated this decision was based on the fact that many of their containers were being shipped to destinations within Puerto Rico and the highway system at that time could not accommodate a 40-foot container. Some of these have been modified by additions to both ends which enables them to be stacked with the standard 40-foot container. Figure 1. shows a modified 35-foot container (bottom container with double end posts).

Figure 1. Modified 35-foot container.

Containers are generally stacked four or five feet high in the hold of a ship or on the deck of a container ship or barge. A 40-foot container can be stacked on top of two 20-foot containers; however, two 20-foot containers cannot be stacked on top of a 40-foot container because the 40-foot container does not have a center support structure capable of holding the inside ends of the 20-foot containers. Figure 2. is a photograph of 40-foot containers stacked on top of two 20-foot containers.

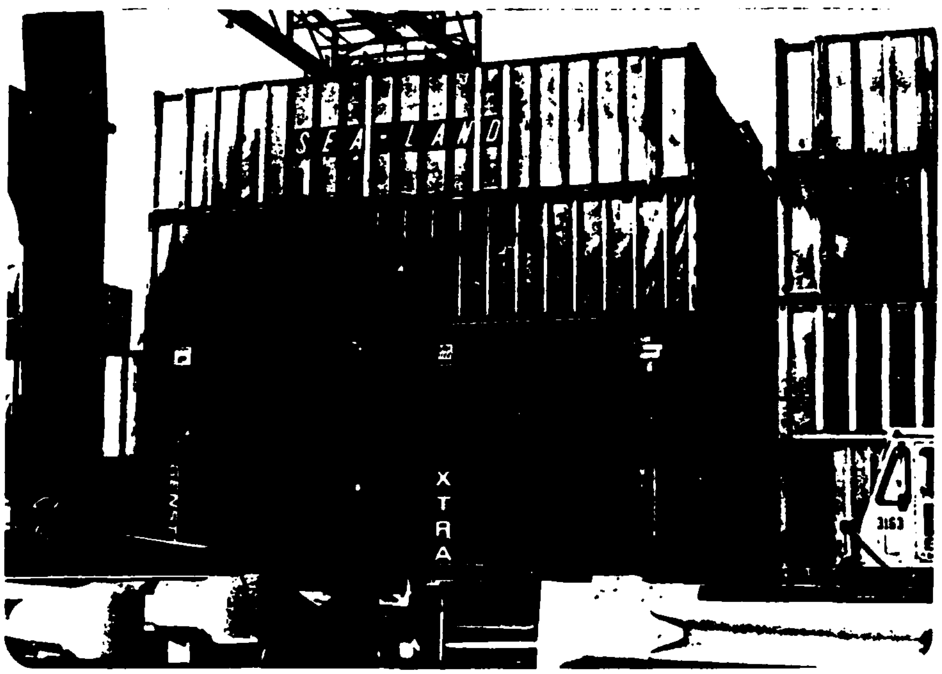

Figure 2. Stacking of 40-foot and 20-foot containers.

Both Sea-Land and US Lines have made recent container purchases which were all 40-foot size. It was their position that the industry will be moving towards a 40-foot container and provided the following reasoning.

- Capabilities of gantry type cranes used for the loading and unloading of containers have increased. Today, the typical public marine terminal is equipped with container handling cranes with capacities of 35-40 tons.[5] Approximately 1,000 ship-to-shore gantry cranes are operating worldwide.

- The majority of the large container ships are being designed to accommodate a 40-foot container.

- An analysis of containerized general cargo shipments shows that 85% of the containers "cube out" before they "weigh-out". In other words, the majority of the containers could accommodate additional weight if the cube space were available in the container to accommodate the additional cargo. (NOTE: This is not true insofar as the shipment of ammunition is concerned, wherein ammunition containers in the majority of the cases weigh-out before they cube-out. This requires extensive blocking/bracing to secure the load. See Page 32 for a more detailed discussion of containerized ammunition shipments in MILVANS.)

An 8'x8'x20' MILVAN can accommodate a load weighing 47,800 pounds (including tare weight). The most recent models of 40-foot containers can accommodate loads in excess of 60,000 pounds (including tare weight). This allows a 26% increase in the weight at a cost of 100% increase in cube. Since the 20-foot MILVAN weighs-out before cubing out, it is apparent that if a 40-foot ISO container were to be used for transporting amunition, the problem of increasing the amount of dunnage would be significantly aggravated.

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[5] Earlier vintage cranes were rated at 30-35 tons. Some of the cranes most recently put into use are rated at 40 plus tons.

(NOTE: The Army has never used a 40-foot ISO container for shipment of ammunition.) Because the continued availability of 20-foot containers is critical to the military for the shipment of ammunition, the trend of the shipping industry away from 20-foot containers to 40-foot containers was investigated further. Contacts were made with two additional major shipping companies, Farrell Lines and the American President Lines. Both company representatives stated unequivocally that because of the large numbers of 20-foot containers presently in the system, and because there are still many countries in the world that have roads and bridges that will not support 40-foot containers, they estimate that 20-foot containers will remain in the system in quantity for the foreseeable future. Discussions with an executive of the IICL supported the statements of Farrell and American President Lines. He indicated that it would take "at least 15 years to exhaust the current inventory of 20-foot containers".

From the above, it would appear as if the container shipping and container leasing industries are giving mixed signals in terms of the sizes of future containers. A closer examination of the information provided reveals that the forecasts of US Lines and Sea-Land and the forecasts of Farrell and American President Lines are really not in conflict. The 20-foot container is the preferred size for trade routes out of Europe because of the type of cargo, i.e., heavier machinery weighs-out before cubing out, and the road network is restrictive. The 40-foot container has traditionally been more popular on the trade routes running from the US to the Far East and the US to Europe, since much of the US cargo is finished goods which tend to be lighter in weight in relation to volume than do raw or semi-finished goods. Prior to 1978, the majority of containers delivered to fleet owners were 20-foot containers. (Approximately two-thirds of all new containers were 20 feet and one-third were 40-feet.) The actual ratio of 20-foot containers to 40-foot containers in the world's container fleet was 2.46 units to one up through the early 80's. Since that time, however, there has been a definite trend towards the 40-foot container. Reports from US container leasing firms indicate that during the first six months of 1984, they were making their first major purchases of containers in recent years. Most of the purchases made by XTRA, ITEL, Sea Containers, Trans America, and TOL have been 40-foot containers. For example, of 20,000 containers ordered by XTRA, the ratio of 40-foot containers to 20-foot containers was 3:1. ITEL ordered 11,000 40-foot containers out of a total of 13,000. Sea Containers followed this trend by ordering 21,000 of 30,000, or 70%, 40-foot containers. Trans America ordered 16,000 containers, of which 14,000 were 40-foot containers.

Why this switch to 40-foot containers? One reason is that many companies are balancing out their currently existing oversupply of 20-foot containers procured in the 1960's and 1970's. Probably more important, however, is the cost of intermodal transportation. With the passage of the Staggers Act, which allows 80-foot maximum truck-trailer lengths, it is uneconomical for shippers to move 20-foot containers over the road. Line haul costs are nearly the same, and, in some cases, are the same for 20-foot containers as they are for 40-foot containers. The result is the shipper actually ends up paying more per ton of cargo moved in a 20-foot container than he pays for movement of that same ton of cargo loaded in a 40-foot container. The same holds true for rail. The optimum load on a flatcar is two 40-foot containers. The loading of four 20-foot containers per flatcar is not feasible because the weight of the loaded containers will exceed the maximum allowable payload weight of the flatcar. Ocean shipping costs have also contributed to the trend towards the larger container. Because many rates are based on actual tonnage shipped, it is, in many cases, cheaper per ton of cargo shipped if a 40-foot container is used. Cargo handling costs involved in the use of 20-foot containers are about double those for 40-foot containers. Lastly, because the tariff rates are based on what the market will bear over specific trade routes, ship owners themselves are discriminating aginst the use of the smaller 20-foot containers. In order to avoid getting "stuck" with a backlog of containers on one end of a route, for example, the tariffs are set so as to discourage the shipper from using the less popular sized containers. Finally, the Military Transportation Management Command (MTMC) which, for many years, equated efficient container utilization with the percentage of container capacity used, now recognizes that true efficiency is a result of per ton costs. As a result, MTMC guidance to shippers now recommends the use of 40-foot containers over 20-foot containers, particularly when linehaul and handling charges are considered.

What then, is the "bottom line" in terms of container size? There is a definite trend towards 40-foot containers for reasons cited above. Based on the relatively large number of 20-foot containers currently in the inventory, there should be adequate 20-foot ISO containers for the transport of ammunition during periods of mobilization up through the year 2000. Army planners, projecting requirements beyond the year 2000, should seriously take into account the fact that the overwhelming majority of containers in the system will be 40-foot containers.

Container Overhaul/Rebuild/Repair

The Jane's Freight Container publication mentioned earlier in this report lists 280 container repairers located in 39 separate countries, of which 21 are in the United States. These companies provide a variety of container services including container storage, container repair and rebuild, container testing, and container cleaning. They range in size from 10 employees to several hundred. Annual container repairs range from less than 100 for the small repairers to more than 10,000 by the major container overhaul companies. As a comparison, the Army's current inventory of MILVANS totals 5,559. MILVAN repairs are accomplished at the Anniston, Alabama, Army Depot and the Tooele, Utah, Army Depot. Anniston repairs, on the average, three or four per week and Tooele averages one per week.

Side Versus Top Versus End Opening Containers and Flatracks

Because of the design operating envelope or cell within which the FMR is to function, the task order highlighted the critical concern of design data and potential availability of side-opening and other type containers that may be suitable for the shipping of ammunition.

As an introductory remark to this concern, discussions with representatives of the Project Manager, Ammunition Logistics (PM AMMOLOG) and the Defense Ammunition Center and School (DACS) reveal that both organizations are investigating the feasibility and utility of side-opening containers for the transport of ammunition. The primary reason for this is to facilitate unloading of ammunition both in a semi-automated mode (high tech forklifts) and automated mode, i.e., the Field Materiel Handling Robot (FMR).

The FMR is currently a conceptual system calling for an unmanned, fully robotic mode of performance for Army field materiel handling tasks. The US Army has a keen interest in applying robotics technology to reduce traditionally labor intensive functions associated with the handling of logistics materiel in the theater of operations. The FMR, if carried to fruition, will function as a heavy lift pallet handling robotic system. The current near-term goal is to design and fabricate a concept demonstrator and research test bed which will operate in a workcell configuration with other systems (see Figures 6 thru 12).

The May 1984 edition of the "Inventory of American Intermodal Equipment" published by the Department of Transportation(6) shows a total inventory of only 1,237 side-opening containers out of a total of 1,735,576 TEU containers. This represents .07% of the TEU container inventory. Discussions with the various shipping lines' representatives on the subject of side-opening containers revealed that the Japanese are also using side-opening containers, primarily for the shipment of long steel products or bar stock and long, small diameter pipes. Information was also provided that Saudi Arabia had used a number of side-opening containers primarily for the reason that it permitted a more visible inspection of the entire contents of a container as a means of detecting contraband materiel. Because of the objections by the shippers and the instability of the side-opening containers, they are no longer in general use in Saudi Arabia. In this regard, one of the standards for ISO containers is that the sides have a 60% load-bearing capability. This presents a design problem for side-opening containers.

Side-opening containers were a topic of discussion with shippers. When queried as to what type of cargo is typically shipped in the US owned and leased side-opening containers, a typical response was: "I really don't know--we have a dozen or so sitting out in the storage area, but I don't remember when we last used them."

(6) Although the Inventory of American Intermodal Equipment is dated May 1984, the information contained therein is 1983 data. Attempts to obtain the 1985 edition revealed that it is not being published. The next issue will be a combined 1985-86 publication and the updated information for this publication is not presently available. The total inventory of containers is therefore estimated to be significantly larger at the present time. However, the ratio of side-opening to end-opening containers is believed to be the same or greater, as we found no recent evidence of significant purchases of side-opening containers by the major shippers or lessors.

Impact of Industry Trends and Practices on Military Requirements

In the above discussions on container size and the type of opening, two critical aspects were surfaced which impact heavily on the US Army's future use of containers in ammunition logistics operations--one of them being industry's apparent trend toward the more economical 40-foot container and the other being industry's apparent lack of "interest" in the side-opening container. Several industry representatives felt that the side-opening container does not meet the ISO requirement for a 60% load bearing capability of the side walls, and it is not structurally sound for use over a long period of time.

The MILVAN inventory is, at most, capable of providing only a few days of ammunition shipments. This is based on a projected contingency rate of 750 per day. In the event of a contingency, the Army would have to rely on commercial containers to sustain combat.

As discussed earlier, there is a strong desire for the side-opening container to facilitate semi-automated and fully automated/robotic ammunition logistics operations. Other means such as extended boom forklifts, a shooting boom FMR, and even a slip-sheet system would greatly enhance ammunition resupply operations.

As can be seen, there are alternatives to a side-opening container, and the 20-foot container will be in the inventory beyond the year 2000; however, a side-opening, 20-foot container without industry's support could be cost prohibitive.

As a point of interest, Figure 3. shows a 40-foot curtain-sided container that was built for Freightliner by Moores of Carnforth. The information on the curtain-sided container appeared in the December 1985 issue of "Container Management", published by Star Publishing, Isleworth, UK. Specifications were not provided; however, a full side-opening 40-foot container lends a lot of credibility to the possibility of using a side-opening 20-foot container for the shipment of ammunition, irrespective of ISO side-wall load-bearing requirements.

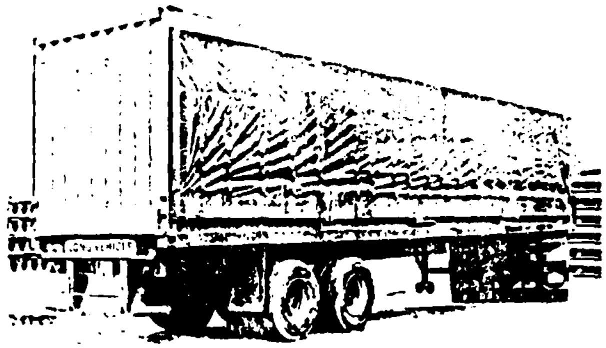


Figure 3. 40-foot curtain-sided container.

MILVANS and Other Containers Used by the Military

Approximately 80% of the ammunition being shipped to Europe at the present time is shipped in MILVANS modified with a restraint system consisting of 25 metal bars. The control of MILVANS is exercised by the US Army Depot, Tobyhanna, Pennsylvania. The current inventory consists of 4,000 MILVANS modified for transport of ammunition and 1,559 unmodified MILVANS used for the transport of other classes of materiel. (At any given time, one to two percent are unserviceable.) Empty MILVANS returning from Europe are stored temporarily in Bayonne, New Jersey; Gulfport, Louisiana; and Sunny Point, North Carolina. Tobyhanna Depot controls the transshipping of the containers from these three points to military customers on an "as required" basis. Although MILVANS are used by all Services, the first priority is for shipment of ammunition.

As stated earlier, MILVAN repair is accomplished primarily at the Anniston, Alabama, Army Depot with a repair rate of three to four per week. MILVANS are also repaired at the Tooele, Utah, Army Depot at the current rate of approximately 50 per year.

The Navy, Marine Corps, and Air Force have all procured a limited number of special containers for storage of "special mission" type ammunition. A summary of containers being used by the military or procured for test purposes for the transport/storage of ammunition is presented at Table 2.

The data in Table 2. were obtained through a written survey of the Services and follow-up telephone conversations. Initial input (survey response) was provided by the Tobyhanna Army Depot, the Army Belvoir Research and Development Center, and the Air Force Directorate of Transportation. Follow-up information was provided by the three above agencies; the Army's Project Manager, AMMOLOG; the Marine Corps; and DACS. Five of the agencies surveyed failed to respond or responded with inadequate data. Follow-up efforts with those agencies resulted in no additional information.

TABLE 2. AMMUNITION CONTAINER SUMMARY (1)

	DESIGNATION	NOMINAL DIMENSIONS (LxWxH) EXTERNAL	NOMINAL DIMENSIONS (LxWxH) INTERNAL (2)	TYPE OPENING & DIMENSIONS INTERNAL (WxH)	WEIGHT IN POUNDS TARE	WEIGHT IN POUNDS PAYLOAD	DESIGNED FOR AMMO	INTEGRAL RESTRAINT SYSTEM	RESTRAINT REQUIRED	USED FOR AMMO/TYPE	AVAILABILITY	US FLAG QUANTITY	OWNER
1a	MILVAN (TYPE II) Ammo Restraint	20'x8'x8'	19'4"x7'7.5"x7'3"	Rear Door 7'5"x7'	5,785	39,015	Yes	Mechanical	Filler dunnage	Yes / All	Inventory	4000	US Army, Tobyhanna
1b	MILVAN (TYPE II) Ammo Restraint	20'x8'x8'6"	19'4"x7'5.5"x7'9"	Rear Door 7'5"x7'6"	5,785	39,015	Yes	Mechanical	Filler dunnage	Yes / All	FY 86 Buy	578	US Army, Tobyhanna
2	MILVAN (TYPE I) General Cargo	20'x8'x8'	19'4"x7'8"x7'3"	Rear Door 7'5"x7'	4,700	40,100	No	None	Yes, blocking and bracing	No (on exception)	Inventory	1,559	US Army, Tobyhanna
3	Commercial Seavan (Dry Van)	20'x8'x8'6" 20'x8'x8'	19'4"x7'8"x7'8.5" 19'4"x7'8"x7'3" 19'3"x7'6.5"x7'2.5"	Rear Door 7'6"x7'6"	3,800 to 5,200 (Varies)	46,000 (Approx)	No, general cargo	None	Yes, wooden dunnage. Approved procedures fielded.	Yes/30 mm, CEU Conventional Munitions, Small Arms	Inventory	717,275	Commercial
4	Special Dry Freight Box	20'x8'x8'6"	19'4"x7'8"x7'9"	Full Side Doors 18'3"x7'	5,800	52,000	No, but redesigned	High strength lashing rings	Cargo Straps.	No	Projected - 1986 Follow-on	300 693	Commercial
5	USAF Flatrack	Three Sizes 20'x8'x4' 20'x8'x5'8" 20'x8'x8'	19'4"x7'8"x3'4" 19'4"x7'4"x4'9" 19'4"x7'4"x7'	Full Access	6,085 6,195 (?)	53,760	No, general cargo, vehicles, etc.	Posts and side rails.	Steel straps and wooden dunnage.	Yes/30mm	Inventory	2 2 2	US Air Force
6	Collapsible Flatrack	20'x8'x8'	19'5"x7'4"x7' 19'5"x7'4"x7'7" (Varies)	Side Access	6,393	49,607	No, machinery, cable drums, lumber, etc.	Wood flooring stake pockets and 10 lashing rings per side. 7,716 pound pull strength.	Yes, additional lashing rings, steel straps and wooden dunnage.	Trial shipment	Inventory	13,749	Commercial
7	Commercial Flatrack Fixed End	20'x8'x8'	19'6"x7'5"x7'7"	Side Access	6,170	46,000 (Approx)	No, heavy and bulky items.	Wood floor, lashing rings and stake pockets.	Yes, blocking and bracing.	Yes/30 mm in ALS containers. (3)	Inventory	Included in Item 6 above.	Commercial
8	Half Height Open Top	20'x8'x4'3"	19'1"x7'7"x2'11"	Rear Drop End 7'6"x3' Open Top with Tarpaulin	4,400	44,800	No, dense cargo, ingots, pipes, metal, waste, etc.	Yes, but inadequate. Only 12 lashing points with 3,310 pound pull strenght.	Yes, more and stronger lashing points in wooden floor version or wooden dunnage system.	Yes, MPS	Inventory	2,187	Commercial and USMC on MPS
9.	Produce Carrier	20'x8'x8'6"	19'4"x7'6"x7'5"	Dual, Rear Door 7'6"x7' Side Grills and Tarpaulins 18'8"x6'10"	6,945	49,055	No, produce	Inadequate, only 5 lashing rings per side. 4,480 pound pull strength.	Yes, more lashing points or adequate side grills and rails.	Test only	Inventory	409	Commercial
10	Side Opening	20'x8'x8'6"	19'5"x7'8"x7'11" (Varies)	Dual, Rear and Side	5,500 (Approx)	52,000 (Approx)	No, general cargo.	None	Yes, to be evaluated.	No/will test	Projected	10	Commercial

NOTES:

(1) Appendix E provides a photograph and data sheet for the containers listed in this table

(2) Some internal dimensions were not submitted for the specific containers shown. In those cases, internal dimensions shown represent the minimum for that type of container listed in the container registers

The data in Table 2. do not reflect actions which do not relate to a specific hardware item at the current time. Two examples of such actions are: the development of a Required Operational Capability (ROC) for a special ammunition container by the MTMC, and an experimental effort by PM AMMOLOG which is in its initial stage of development and will call for the testing of container candidates for the shipment of ammunition.

Some of the test efforts and industry trends relative to intermodal shipments dovetail in specific areas such as the use of metal lashing; a possibility in containers as well as on flatracks. These aspects will be discussed in a later section on dunnage.

Possible Alternatives for the FMR Workcell Layout

One possible alternative to a side-opening container for the transport of ammunition is a flatrack which consists of a strong, reinforced base with or without collapsible ends. Both sides are open. The flatrack offers the advantages of full access and stackability (collapsible type) for retrograde. With the ends folded inward, four can be stacked in the space of one container. During visits to commercial packaging companies, various types of commodities were observed being secured to flatracks. Figure 4. is a load of large air conditioning units that have been stacked two high. Figure 5. is an Army 5-ton wrecker that had been secured with double, two-inch steel banding in lieu of blocking and bracing and tie-down chains which was the earlier method used for securing such cargo to rail cars and flatracks. It was stated that this change reduces the cost of securing a large vehicle on a flatrack from approximately $800.00 to approximately $200.00 - $250.00. Discussions with these commercial packaging company personnel relative to the feasibility of securing palletized artillery and boxed ammunition on flatracks using steel banding resulted in the conclusion that the dunnage costs and associated labor

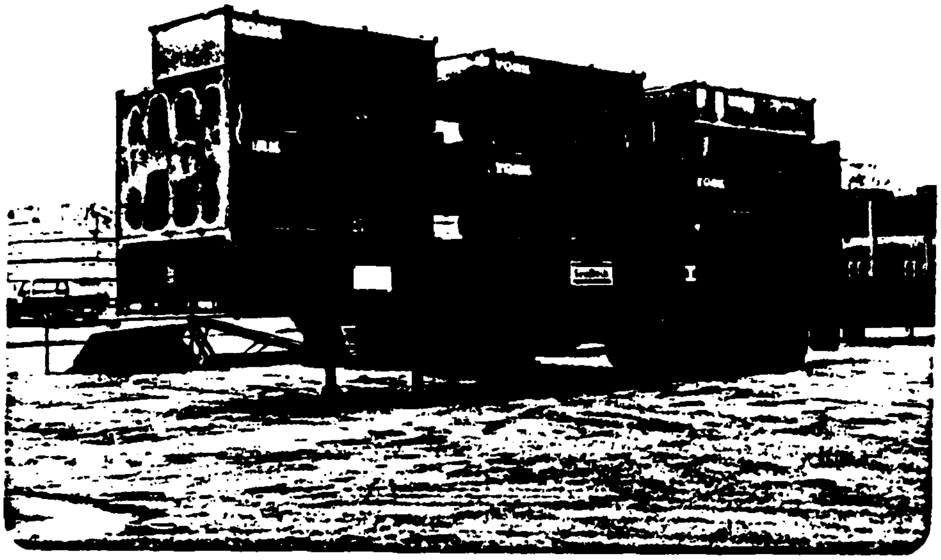


Figure 4. Air conditioning units on flatrack for securing with steel banding.

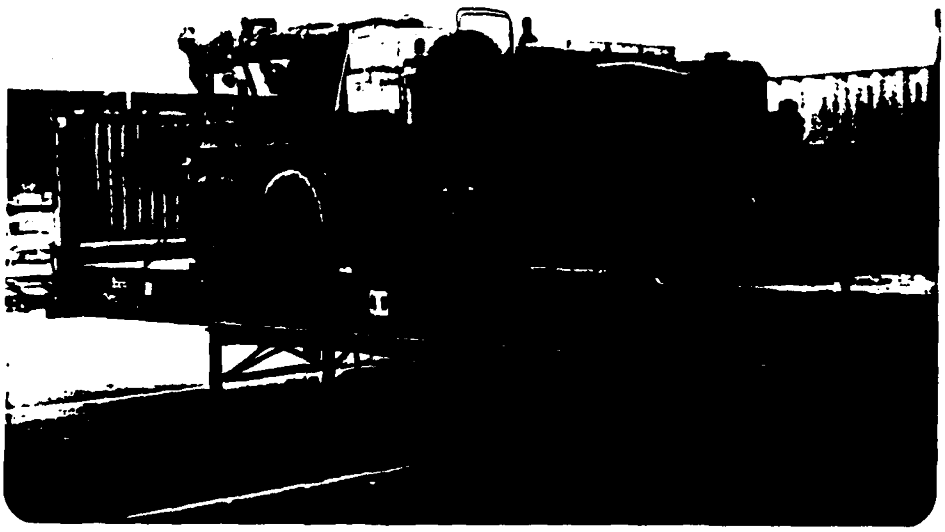


Figure 5. Wrecker on flatrack secured with steel banding.

costs could be reduced significantly by using steel banding for securing ammunition pallets to flatracks. It was also suggested that consideration be given to modifying ISO containers and MILVANS to equip them with a series of lashing rings on the sides and floor similar to those on flatracks so that flexible steel bands could be used in lieu of the rigid metal bars and extensive wooden dunnage for the securing of ammunition, at a small fraction of the costs associated with wooden dunnage. A further discussion of this is contained on Page 37 under the title "Wooden Dunnage and Other Methods of Securing Ammunition Shipped in MILVANS and Commercial Containers".

As of 1984, the Inventory of American Intermodal Equipment lists a US inventory of 17,030 flatracks. Commercial packers expressed the opinion that this inventory has been significantly increased since that time. This opinion is supported based on the increasing number of flatracks that they are using for shipping the heavier items of cargo. In this regard, a half-height flatrack is beginning to enter the inventory which may be ideally suited for transport of artillery projectiles. The USMC is planning to use flatracks for the long term storage of ammunition in the maritime prepositioned ships (MPS) in lieu of the unventilated commercial containers. Currently, the ammunition is stored in MPS ships in unventilated 20-foot containers and 20-foot open-top containers. The flatrack and open-top container storage will make up about 75% of the required ammunition stored in MPS. Approximately 25% of the ammunition, composed primarily of special purpose items, must be secured in closed containers. In view of the above, the authors consider it desirable that an alternative workcell layout for the FMR field experiment include a flatrack in accordance with Figure 6.

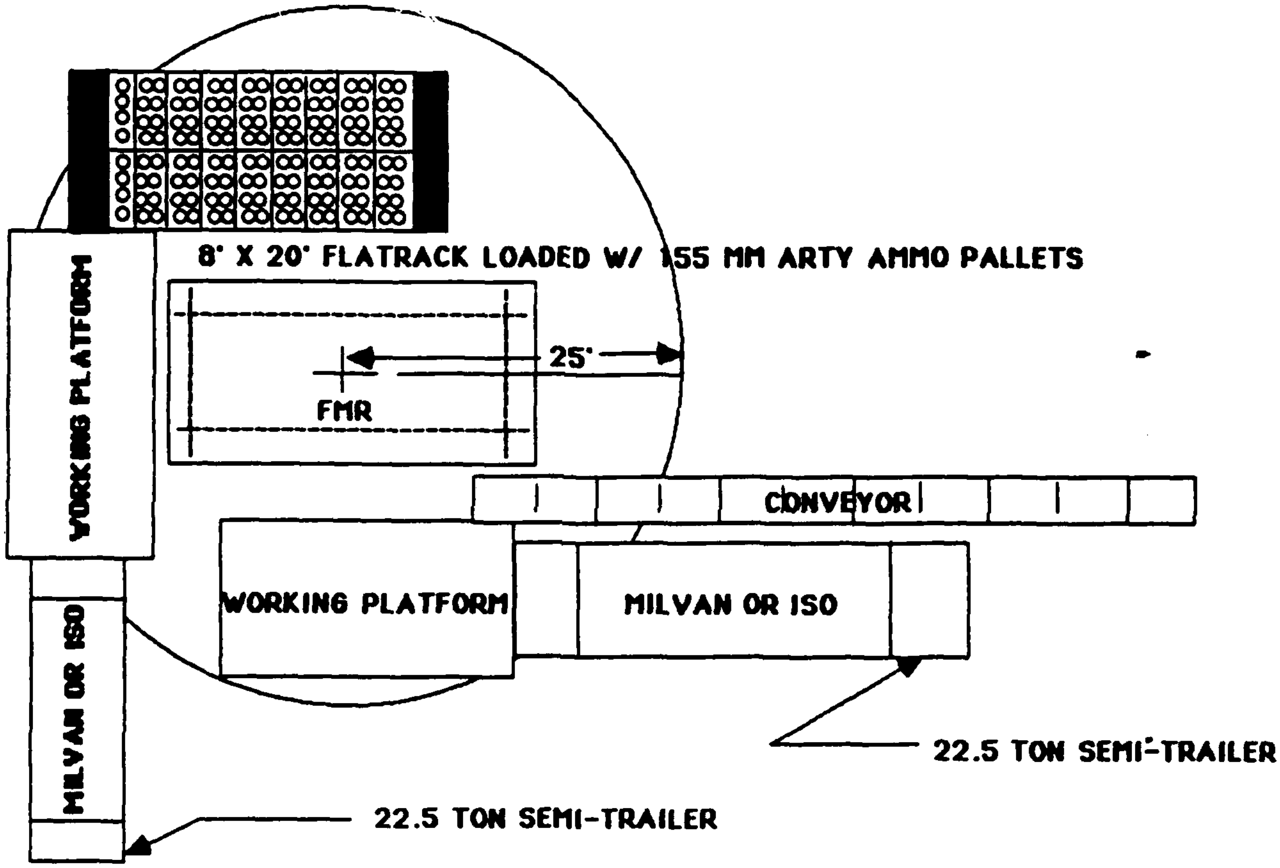


Figure 6. Alternative FMR Workcell.

Although the current inventory of 20-foot ISO containers with side-opening doors is extremely small in comparison with the total inventory (.07% as pointed out earlier). The US Air Force has procured a limited number for test purposes. The Air Force advises that the opening on one side is 19 feet (as compared with a 20-foot container). The height of the opening is approximately seven feet, six inches. It is also considered desirable that one of these be borrowed from the US Air Force, and that it be included in the workcell layout for the FMR field experiment as shown in Figure 7. DACS will accomplish the safety tests for the Air Force containers and PM AMMOLOG is monitoring and integrating the effort into the ammunition container program.

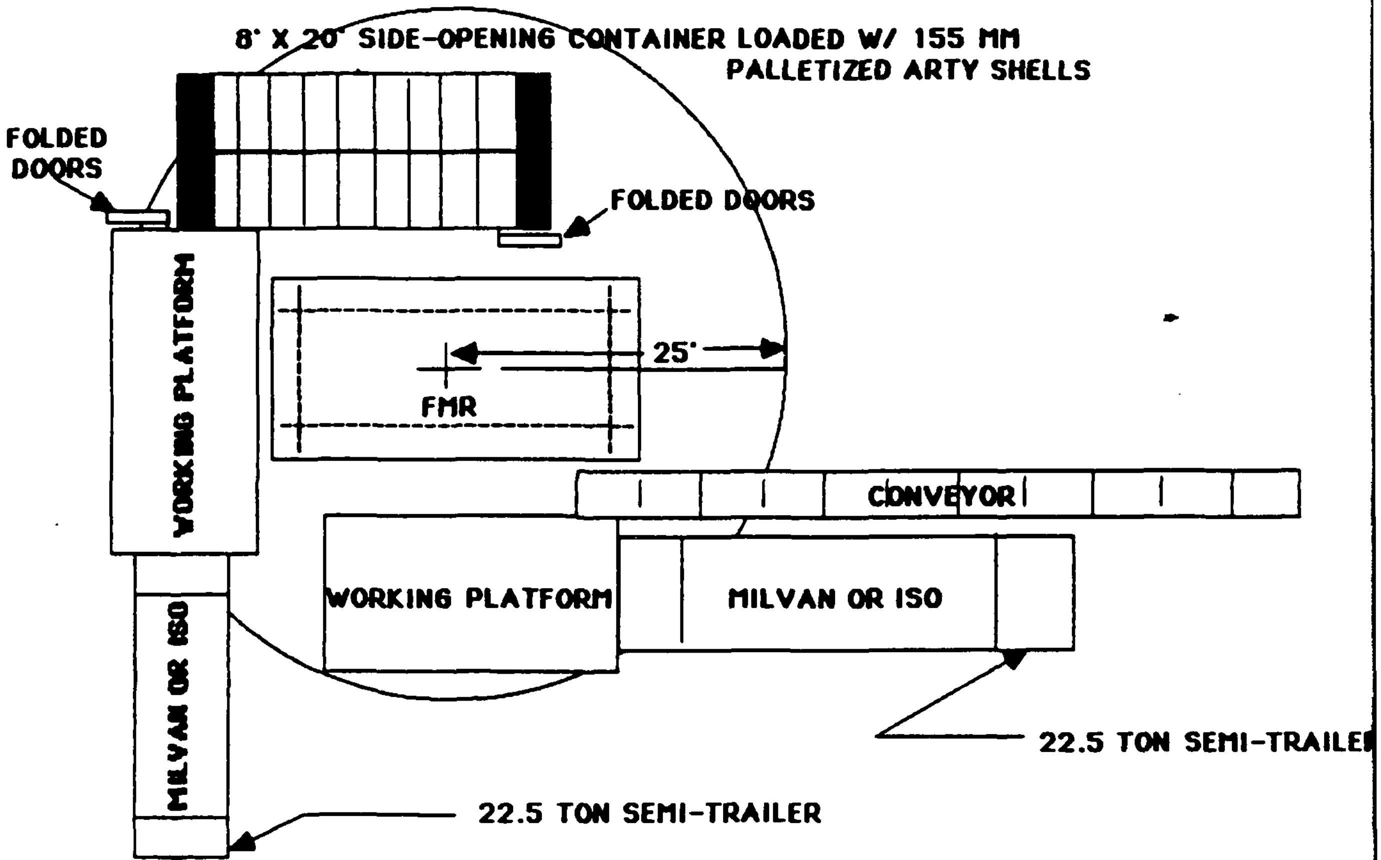


Figure 7. Alternative FMR Workcell.

It is anticipated that a problem may be experienced in the automatic loading and unloading of end-opening containers with robotic devices, such as the FMR discussed earlier, due to the inability of the robotic arm to reach into the rear sector of the container. One method of overcoming this would be to use a slip sheet underneath the entire load which could be pulled out in one single movement onto a platform so that the robotic unloading device could approach the load from either side or end. The Army had a research project with Automatic Truckloading Systems Corporation under the title Pre-Staged Ammunition Loading System (PALS) that investigated the feasibility of using slip sheets to remove palletized loads of ammunition from containers (see Figures 8. and 9.).

The PALS program has been terminated; however, it was intended to give CONUS ammunition depots, plants, and ocean terminals the capability to meet a mobilization goal of outloading 1,000 commercial containers per day with reduced manpower and material when compared to existing outloading methodologies. PALS consisted of six major subsystems: transfer vehicle, container loader, container indexing, container dunnage, materials handling, and inspection and documentation. A component of PALS, the Slip Sheet, is used to extract an entire load of ammunition, weighing up to 20 tons, from cargo containers as a unit load, thereby, allowing easy access to the palletized load by materials handling equipment. The Slip Sheet system consists of a polyethylene sheet, which is placed on the floor of the cargo container prior to ammunition being stuffed, and a clamping device which is used to extract the sheet from the container. Various methods can be utilized to provide extract force, e.g., winch, tow bar, etc. Since this effort is well documented in reports available to the US Army Human Engineering Laboratory, no further discussion will be presented in this report. The reason for noting it is the renewed interest and hardware being introduced to speed up the loading and unloading of containers

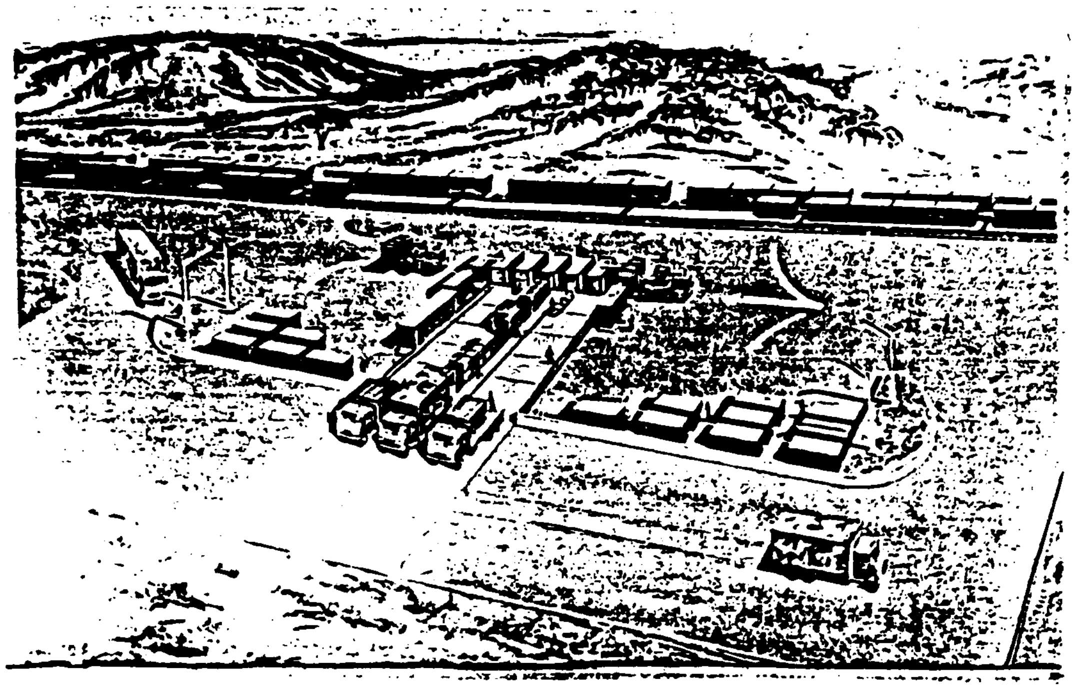


Figure 8. Prestaged Ammunition Loading System (PALS).
(Artist's illustration of an outloading facility.)

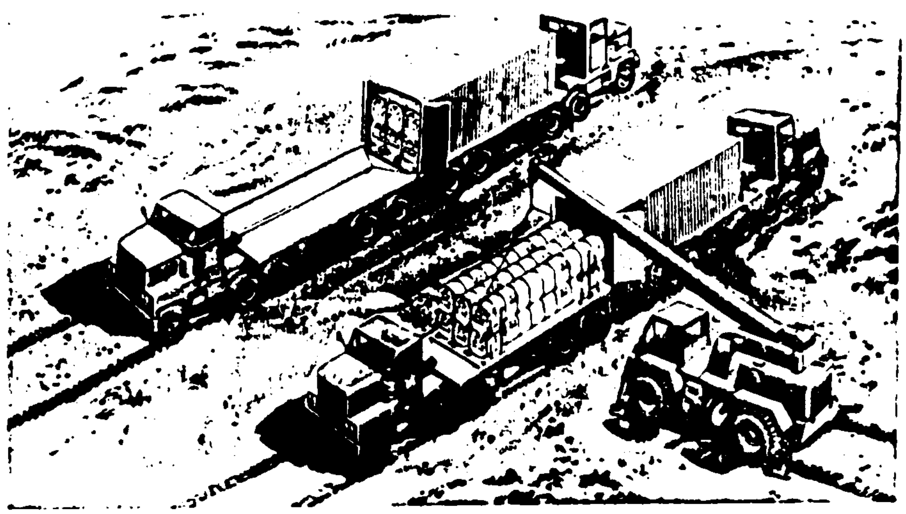


Figure 9. Slip Sheet System.
(Artist's illustration of the extraction of cargo from a container and the subsequent "pick" to transfer the load from the trailer.)

and trailers needed to support JIT (Just-in-Time) transportation. Industry can no longer afford to have large quantities of material taking up expensive storage space awaiting call forward to manufacturing. Neither can vendors afford to have large quantities of finished products taking up warehouse space. Therefore, JIT related concepts are being introduced in several areas of manufacturing, warehousing and transportation; one method being used to speed up loading and unloading is called slug loading/unloading. In this scheme, an entire trailer or container load is handled at once. Air casters, rollers, and cables are all being used with some success. Figure 10. is a sketch that shows the use of rollers on the floor of the container as a means of reducing friction so that an entire load can be inserted into or removed from a container at once.

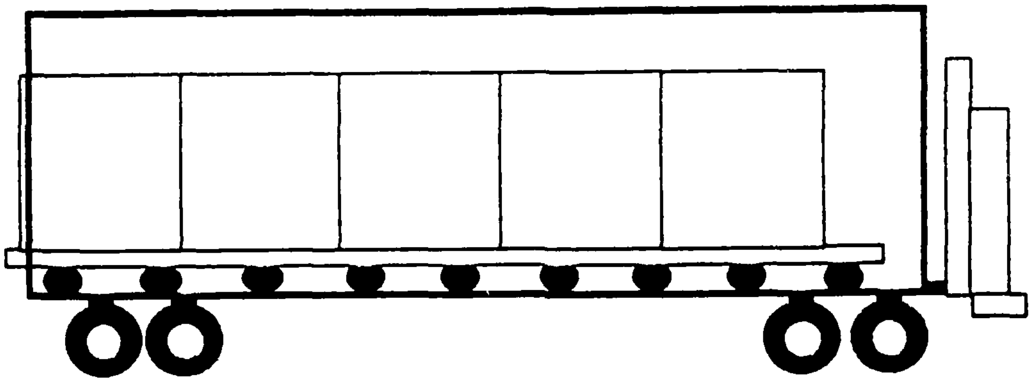


Figure 10. **ROLLERS USED TO FACILITATE UNLOADING OF CONTAINERS**

Therefore, a third alternative workcell for the field experiment of the FMR would be to use a slip sheet from the former PALS program. A slip sheet could be placed inside a standard 8'x8'x20' ISO container and then loaded with pallets of either 105MM boxed tank rounds or palletized 155MM artillery rounds. The slip sheet with the palletized shells could be pulled out onto a working platform using some sort of winch to a location where the FMR could move the pallets onto a conveyor as shown in Figure 11.

Because of the high interest within the Army and the extensive testing planned for the Palletized Loading System (PLS), it is suggested that the upload of PLS with ammunition also be included as a workcell configuration for the FMR field experiment as shown in Figure 12. The PLS consists of a truck chassis, an integral hydraulic load handling mechanism, and compatible trailer, and a number of flatracks. The system is capable of self-loading

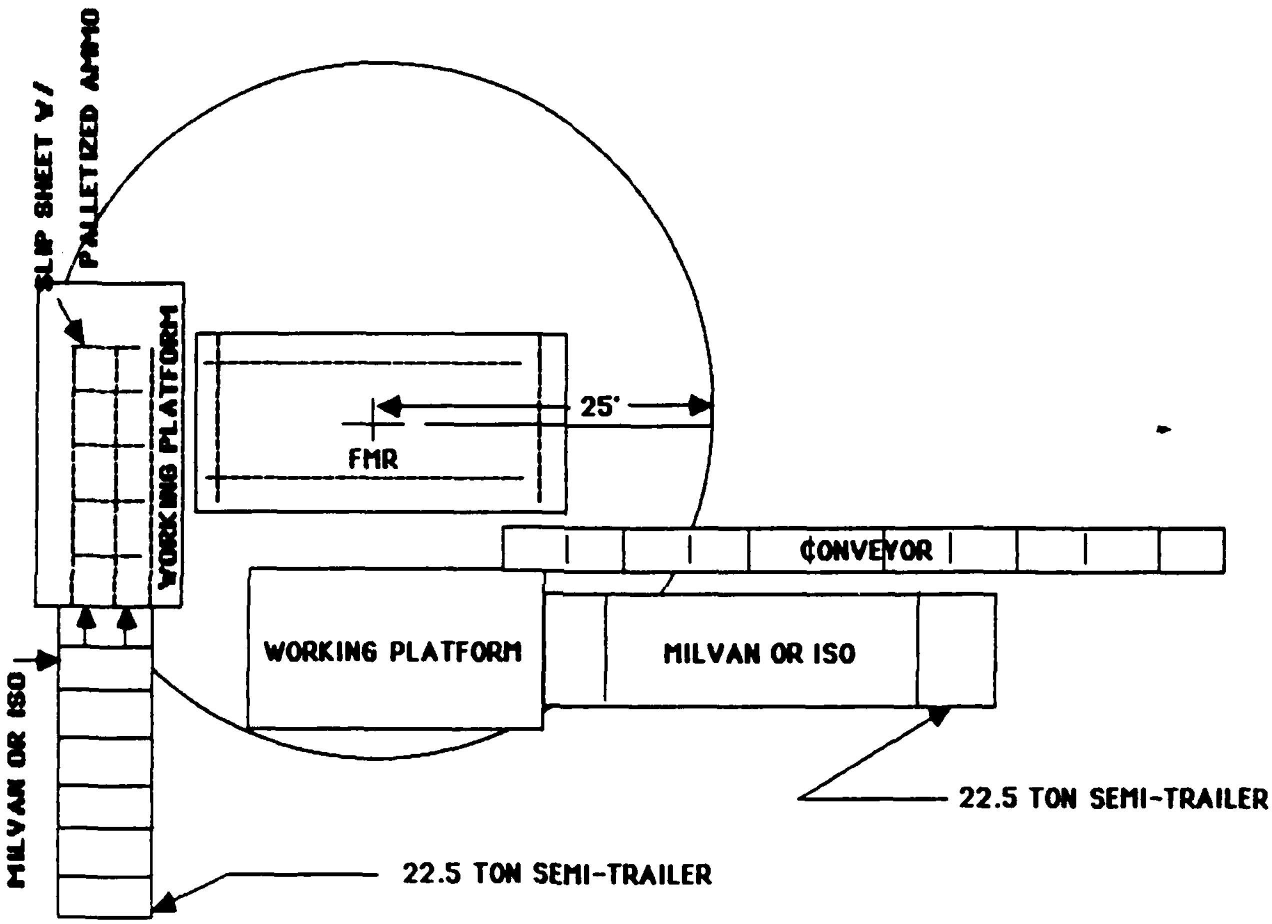


Figure 11. Alternative FMR Workcell.

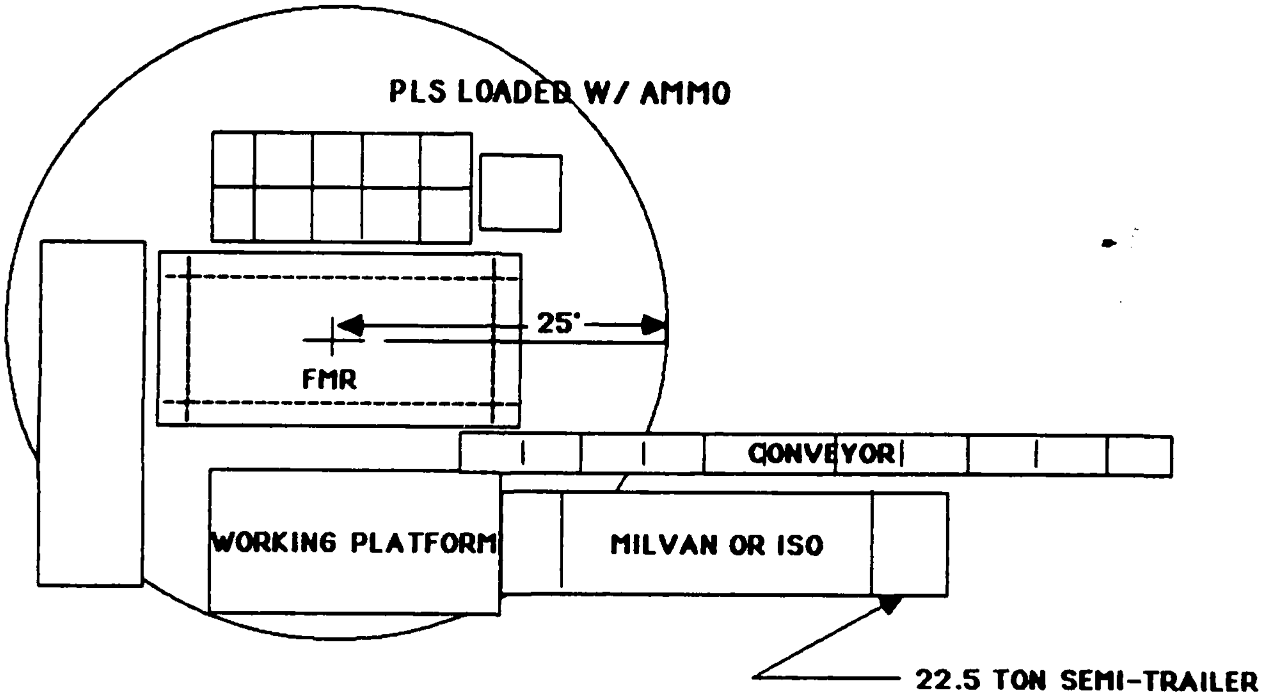


Figure 12. Alternative FMR Workcell.

and unloading the flatracks from the ground onto the truck chassis using the integral load handling system. The vehicle mounted load handling system also has the capability to load and unload flatracks onto the companion trailer (see Figures 13. and 14.).

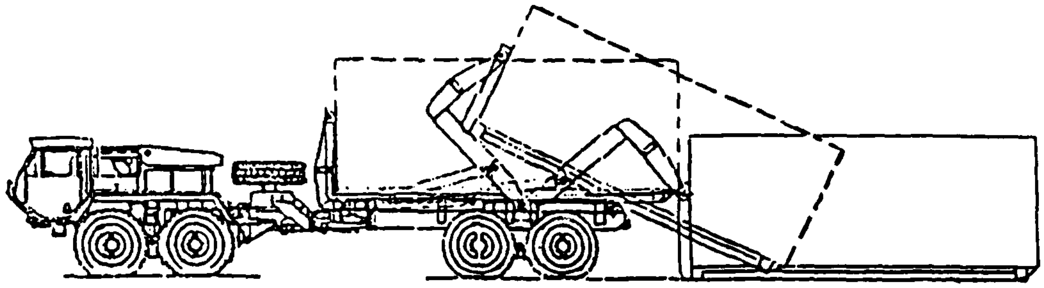


Figure 13. Palletized Loading System (PLS). (Artist's illustration of a container being raised on the PLS flatrack from a ground position through an intermediate position to the loaded position on the PLS trailer.)

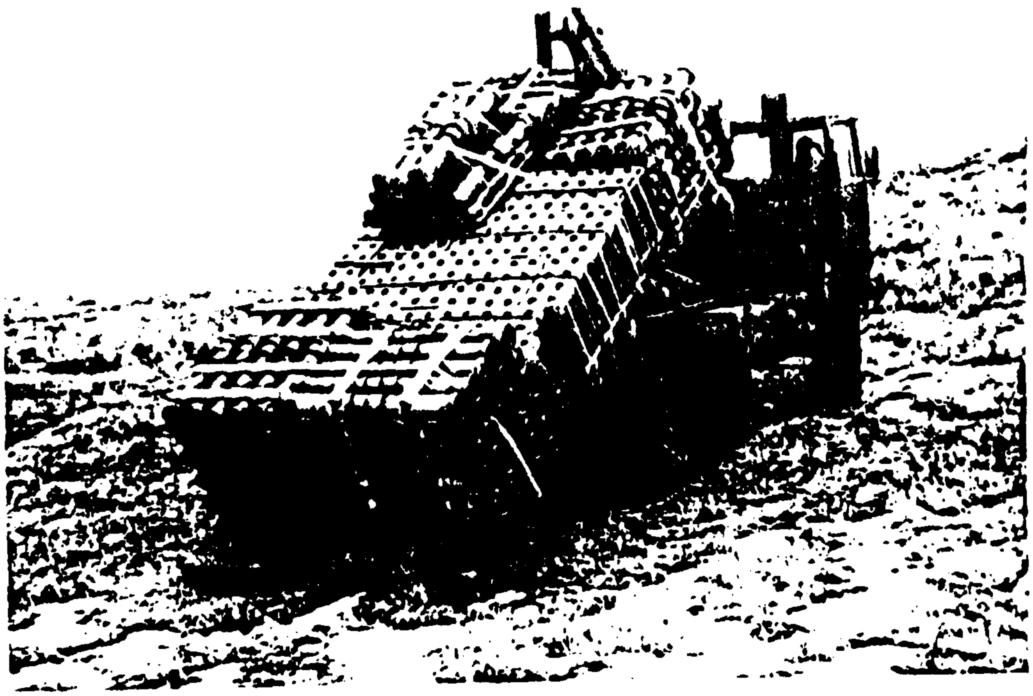


Figure 14. Palletized Loading System (PLS). (Photograph of a load on the PLS flatrack in the intermediate position.)

Wooden Dunnage and Other Methods of Securing Ammunition Shipped in MILVANS and Commercial Containers

The current method of securing ammunition in MILVANS and commercial containers includes a high expenditure of time and cost (labor and material cost). MILVANS are affected to a lesser degree than commercial containers because of the mechanical restraint system employed in approximately 70% of the MILVAN inventory. Since the MILVAN inventory would represent a small fraction of ammunition shipped (about the equivalent of two days) in the event of mobilization and because of the total reliance on wooden dunnage for commercial containers, this section will focus on ammunition restraint in commercial containers--upon which almost 100% reliance will be placed in the event of mobilization.

The concern of time expenditure in the use of wooden dunnage impacts on ammunition resupply in three primary ways: 1. the considerable time(labor cost) to stall the dunnage; 2. the time delay in the event of mobilization; and 3. the unacceptable time expended in removing the dunnage in-theater. The in-theater time delay becomes more critical as the "unstuffing location" is moved forward (closer) to the combat user. With the emphasis on maneuverability on the future battlefield, coupled with the increase in numbers of sophisticated weapons systems and rates of fire, the archaic wooden restraint system could result in the inability to provide ammunition support to forces operating under Army 21/Airland Battle concepts. Table 3. provides an example of the cost in time and dollars associated with the use of dunnage for ammunition restraint in commercial containers. Data were obtained from a US Army DACS report on tests conducted and actual shipments made to OCONUS destinations.

TABLE 3.

Cost to Stuff Ten Commercial Intermodal Containers with 105MM Tank Ammunition Using Wooden Dunnage

Event	Man-Hours	Labor Cost	Material Cost	Total Cost
Prefabricate Dunnage	129	$2639.71	$1659.72	$4299.43
Installation of Front Blocking Assembly	21	429.72		429.72
Stuff Container	48	974.22		974.22
Installation of Rear Blocking Assembly	24	491.12		491.12
TOTAL	222	$4534.77	$1659.72	$6194.49

Man-hours per container = 22.2
Cost per container = $619.45 (1979 dollars)
Estimated current cost = $953.95 per container (1986 dollars)

Source: US Army DACS Report EVT 4-79.

Today's total requirement for ammunition in-country in Europe exceeds 1,500,000 short tons.

TABLE 4.

Total Class V European Requirements

Item	Short Tons	Percent of Requirement
8" Projectile	338,777	22
155MM Projectile	551,710	36
Subtotal	890,487	58
8" Propellant Charge	105,794	7
155MM Propellant Charge	166,458	11
Subtotal	272,252	18
Total 8"/155MM Family	1,162,739	76
Small Arms	50,717	3
Tank Ammunition	65,187	4
Mortars	56,357	4
All Others	187,804	13
Total SA/Tank/Mortar/Other	360,065	24
Grand Total	1,522,804	100

Source: WARS Report RCS-CSGLD 1322(R1), Part 1-C as of 30 September 1983.

At 20 short tons per container, there would be a requirement for 75,000 containers to replenish the 1.5M short tons in-country stock. The requirement in the event of mobilization would be between 750 and 1,000 containers per day. At a cost of about $1,000.00 per commercial container (see Table 3.), the daily cost would approach $1,000,000. Based on Table 4. above (as an example), the cost to stuff the 75,000 containers would approach $75,000,000.

The industry survey revealed the use of numerous forms of restrain for cargo in intermodal ISO containers. Despite established safety requirements in the shipment of ammunition, it was the consensus of industry representatives that the military's use of wooden dunnage may be excessive in terms of the amount of dunnage and the quality of wood (Grade #1 and #2) that is used. See Tables 5. and 6.

TABLE 5.

Material Required for One Container Load
of 155MM Projectiles

Bill of Material

Lumber	Linear Feet	Board Feet
1"x6"	471	236
2"x2"	6	2
2"x3"	187	94
2"x4"	244	163
2"x6"	432	432
4"x4"	36	48
Total	1,376	975

Nails	Number Required	Pounds
4d(1-1/2""	144	3/4
6d (2")	260	1-3/4
10d (3")	794	12-1/4
12d (3-1/4")	80	1-1/4
16d (3-1/2")	224	5
Total	1,502	21

Plywood, 1/2"--91 square feet required--126 pounds.
Door post vertical retainer--2 required--64 pounds.

TABLE 6.

Commercial Versus Military Dunnage

	Commercial Sector	US Military
Grade of Lumber Used	Grades 3 and 4	Grades 1 and 2
Average Time to Brace/Block	20 Minutes	10-12 Hours
Amount of Lumber Used		
155MM Shells	(Note #1)	1376 Linear Feet
Air Conditioning Units	100-125 Linear Feet	(Note #1)
Types of Dunnage In Use	Wood, Rubber and Paper Air Bags, Steel Bands	Wood Metal Bars

NOTE #1: Commercial industry does not ship ammunition in large quantities. Comparable commodity is air conditioning units or air compressors.

The problem is compounded further by the variation in ammunition pallet configurations that would require special dunnage configurations, either prefabricated or constructed during stuffing of the container. Table 7. represents a sample of the varied pallet configurations. Only two (.50 Cal. and 5.56MM) are the same dimensions.

With industry's continued trend toward containerized versus break bulk cargo, there is no avoiding the container restraint system cost issue.

Industry is currently using other types of cargo restraint systems. Paper air bags are considered to be marginally effective and are easily torn. Laminated rubber air bags are effective with temperature limitations and are repairable if damaged. The effect of changes in temperatures are obvious and they do not provide the needed restraint if the container transits temperature extremes. Steel lashing bands are used with a high degree of success and are relatively cost effective. Steel lashing bands have application to containers as well as flatracks. See discussion and figures beginning on Page 22 of this report.

Other alternatives to wooden dunnage have been addressed by the US Army community and have undergone testing or are planned for evaluation.

Alternatives to wood include foams, pre-formed plastics, light metals, steel banding with an aluminum or steel frame (flatrack), steel bands inside containers equipped with "O" or "D" rings, the Internal Restraint System Kit (IRSKIT), and PALLA-GARD.

A DACS Report (7-70) on the Road and Tilt Test of Foamed-in-Place Blocking of Containerized Ammunition concluded that foamed-in-place blocking (See Figure 15.) is satisfactory for shipment of ammunition in containers via highway and/or water, cost of test materials were not a valid comparison with the cost of wood, and that precast sizes would save considerable man-hours. The report recommended further evaluation. Other types of foam blocking and bracing are feasible.

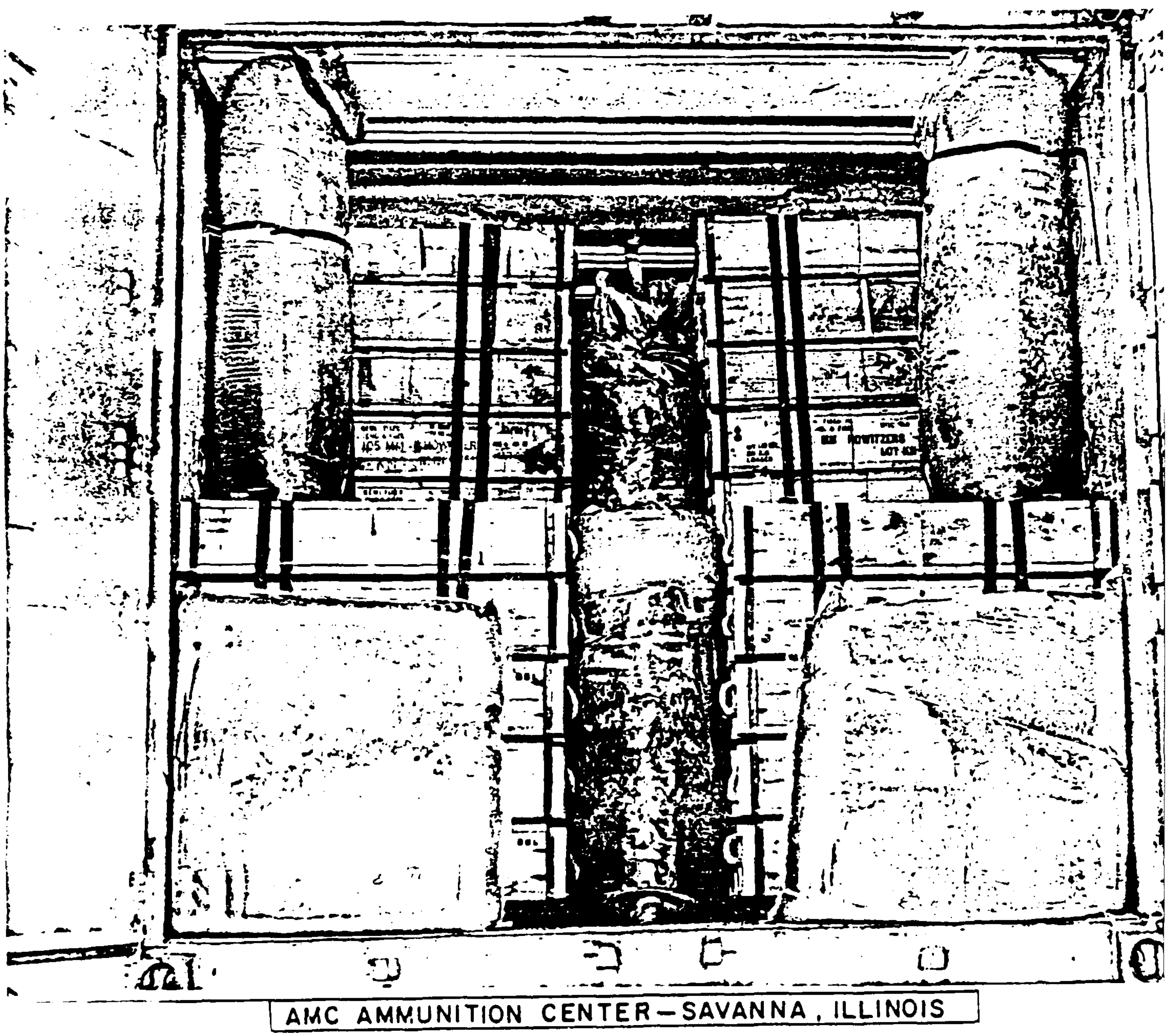


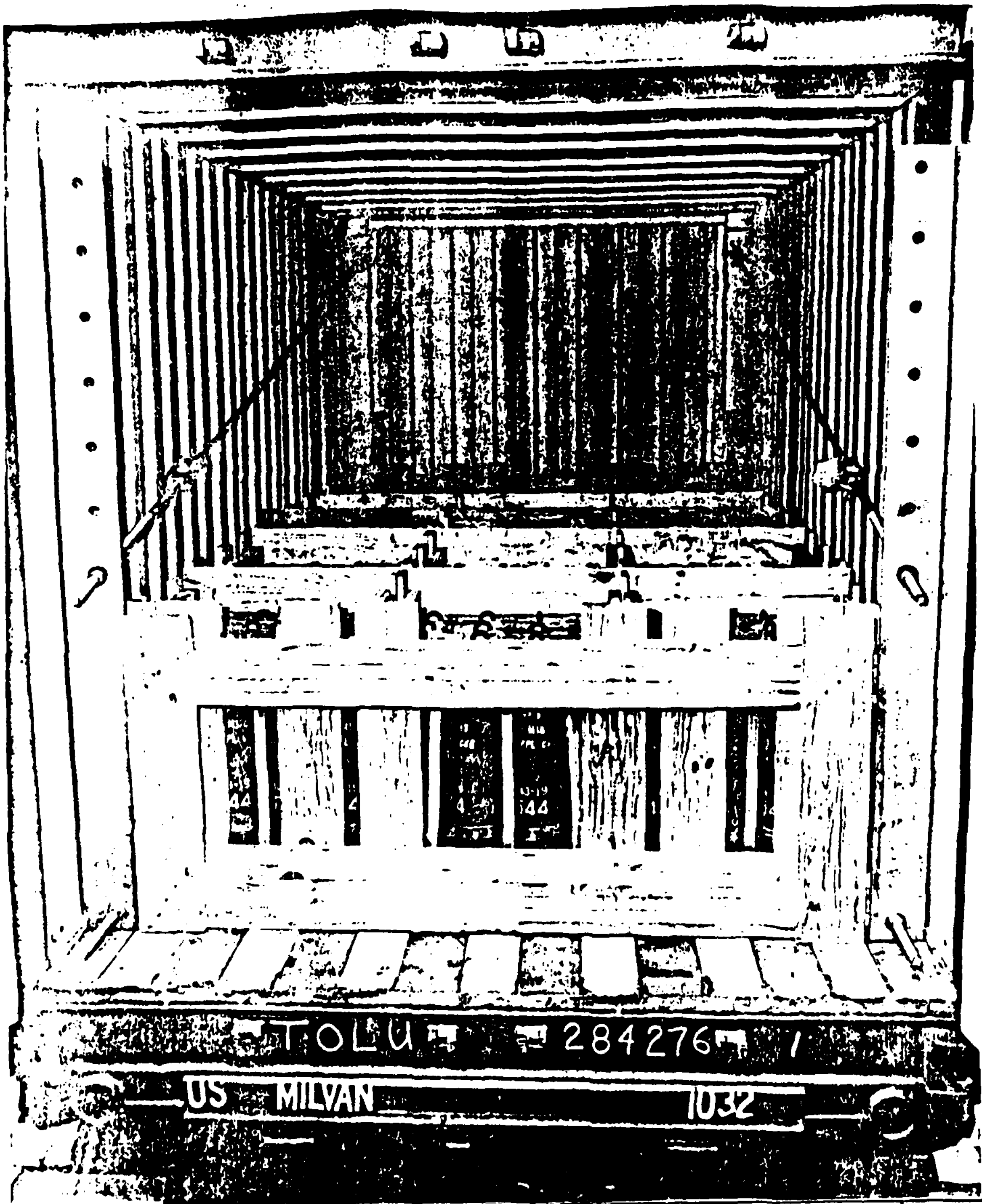
Figure 15. Foamed-in-place blocking.

Pre-formed plastics have not been tested; however, consultation with a member of the industry revealed that pre-formed blocking and bracing could be made of adequate strength for ammunition restraint. An example of such a plastic is the DACS tested Loose Projectile Restraint System (LPRS). The blocking and bracing:could be made of high strength, low weight, non-flammable, and non-toxic materials; could be achieved at a relatively low cost; and of a strength and durability to be reusable. Stuffing and unstuffing times could be reduced and the components could be retrogradable in empty containers.

Light metals have been tested and the obvious trade-off is weight versus durability. The MILVAN restraint system is an example of the use of metals for restraint.

Steel bands present considerable advantages and have been used with flatracks in a system approved for the shipment of ammunition. High strength bands of relatively low cost are scheduled for further experimentation with flatracks and containers equipped with "O" and "D" rings. The Air Force has scheduled testing of containers, and it is anticipated that PM AMMOLOG will investigate the use of steel bands with flatracks and in containers. As previously mentioned, the Marine Corps intends to replace about 75% of the containerized ammunition aboard MPS shipping with flatracks using steel banding for restraint.

The IRSKIT, developed by the US Naval Weapons Handling Center-Earle, Colts Neck, NJ, has been tested by DACS with the recommendations that the current inventory be maintained and production be initiated in the event of a contingency. See Figure 16.



DEFENSE AMMUNITION CENTER AND SCHOOL- SAVANNA, IL

Figure 16. Internal Restraint System Kit (IRSKIT)

The PALLA-GARD (NP Marketing Corporation) is a commercial system that was tested by DACS and, if modified, is considered to be satisfactory for ammunition restraint. See Figure 17. PALLA-GARD has specialized and replaceable floor-gripping teeth to restrain cargo. During transit, ratcheting capabilities allow forward shifting with the resulting closure of void spaces. As shown in Figure 17., they are collapsible and nestable.

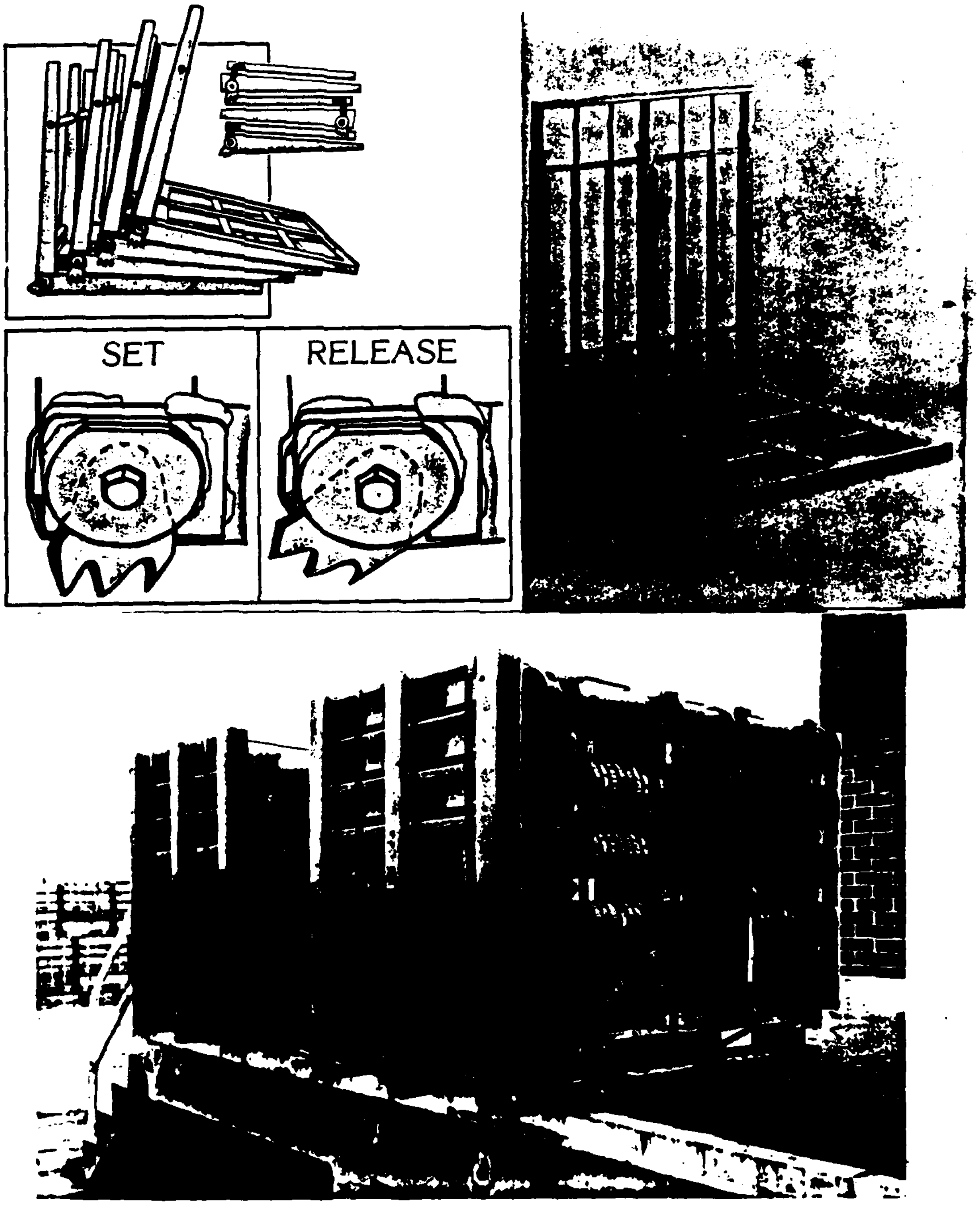


Figure 17. PALLA-GARD.®

In summary, the use of wood for dunnage in ammunition containers is expensive and time consuming. Based on the practices in industry and comments by industry representatives, it would appear that a review of the strict requirements is in order. A thorough investigation of alternatives could perhaps identify ways to reduce the associated cost and time through the use of cheaper, reusable materials that are easier to install and remove and, thus, improve the ammunition logistics system.

Container Security

A major advantage often cited for shipping cargo in containers is that of security. Unlike break bulk cargo, containerized cargo is not in view of the would be pilferer, so he has no way of knowing the contents. Also, each container is sealed when loaded and as long as the seal remains unbroken, the integrity of the container cargo is assured. What if the seal is broken, however, and part of the contents are removed? Who is responsible? Using the Baltimore Port as an example, the Maryland Port Administration advised that it is responsible for the overall security within the Port of Baltimore. Security responsibility is further broken down into the various terminals within a port. The Dundalk Terminal, a public terminal, for example in the Baltimore Port area, has its own security force that supports all of the shipping lines and packers authorized to conduct business within the Dundalk Terminal area. For private ports and terminals, a similar security organization is assigned responsibility, the cost of which is borne by the shippers and other agents authorized to do business in a particular port or terminal within a port area. Final responsibility for the contents of a particular container, however, rests with the shipping company that contracted to transport the cargo of a manufacturer or supplier. The same situation prevails for containerized and break bulk cargo. Once the shipper picks up the containerized cargo at the customer's place of business, he assumes responsibility for the cargo until it is delivered to the final point of destination.

The reader is reminded that military shipments of ammunition will not be dispatched from general cargo ports either in peacetime or time of mobilization. Rather, ammunition will be loaded at special ammunition piers whether it is containerized or break bulk. As such, the military will generally provide its own system of security, both at the CONUS outloading port and the OCONUS port of final destination.

Manual and Automated Tracking of Containers Enroute

One of the major concerns in the wide use of containers by the military is the capability to rapidly locate a particular cargo in a container that may be one of hundreds of containers on a beach in support of a large military operation. Commercial manufacturers have designed a system that uses small electronic cards or computer chips that can be affixed to the outside of a container. This small card/chip lists the identification of the container as well as the container contents. A device capable of projecting a sharply focused electronic signal is used to scan the various containers as a means of locating the desired cargo. One such device,manufactured by the Lockheed Corporation,was recently demonstrated as part of PROLOG 85, held at Fort Eustis, Virginia.

In order to determine the real utility of such electronic tracking devices to locate a particular container and to identify its contents without physically opening it, queries were made to the various shipping companies. Although we had anticipated that similar automatic tracking systems would be in rather wide use throughout the container shipping industry, it was learned that this is not the case. Several years ago, Sea-Land Service initiated an automated system of machine readable symbology (bar codes) similar to the DoD's Logistics Applications of Automated Marking and Reading Symbols (LOGMARS). The system was in use for only a relatively short period of time and was then discarded in favor of a previously used manual system. Two reasons were cited for the return to the manual system. First, was the requirement to check custom seals while containers are in a port area. The second reason is that labor unions require a designated number of "container checkers" as part of the unionized labor force under contract within a terminal. The use, and associated costs, of an automated system could therefore not be justified in that the checkers were given responsibility for checking the integrity of the customs seals and, at the same time, perform any required inventory check and verification of location of a particular container in a designated storage area within the confines of the terminal. Tracking of a container from a customer's warehouse to its arrival at an ocean terminal is through the normal vehicle dispatch system if that leg of the movement is by vehicle, or the standard railroad bill of lading system if the movement is by rail. Based on discussions with several shipping lines, it is estimated that approximately 20% of containers are stuffed by a container stuffing company or the shipping company within the terminal area. In such cases, the cargo is usually moved by customer vehicles to the port container stuffing warehouse and the standard inventory of container content by container serial number is prepared at the time the container is stuffed. A ship is then designated for movement of the container to the port of destination and the "container checkers" manually track the container from the time it leaves the container stuffing facility until it is loaded within a numbered hold of an ocean going vessel or numbered position if it is shipped on the deck of a container barge or ship.

When a similar query was made to the US Lines, their representatives stated that they had experimented with an electronic tracking system at the New York Port. Like Sea-Land, they soon returned to a manual system designed around the labor union requirement to have "container checkers" as part of the work force.

A British Aerospace Dynamics group recently developed an x-ray container examination system which is being used by customs inspectors to check the contents of containers similar to the x-ray system being used to check suitcases and carry-on luggage at airports. This device is credited with the expediting of containers through terminals previously experiencing lengthy delays due to customs checks.

Discussions with still other shippers indicated that tracking of containers is no problem in that there are not great numbers of containers filled with cargo in any location of a terminal storage area at any time. A container coming into a terminal for shipment overseas is often loaded on a ship the same day it arrives. Normally, the customer containers arrive by tractor trailer with the name of the ship generally known by the time the container arrives at the terminal. The vehicle is then directed to an area beside the ship where the containers are off-loaded. From this point, the gantry crane lifts the container directly to its designated location on a ship.

Temporary storage areas within the terminal are designated by either numerals or letters and this designation is indicated on the shipping documents which are then combined by computer programs operated by the shipping lines. When a customer wants to know the status of his containerized shipment, a query of the computer will provide information on its present location within the terminal, the ship it is to be loaded on, the ship's time/date of departure and estimated time/date of arrival at the port of destination. As a final comment, shippers commented that they never really had a problem in tracking cargo enroute even in the days of break bulk shipping except for the problem of the high rate of pilferage. With the advent of cargo containers, the tracking of cargo enroute has been significantly simplified. Perhaps the real improvement has been in the ability to provide a customer with near real-time or real-time information made possible by modern computers.

Retrograde Container Loads

The economy of an ammunition container system cannot necessarily be justified in terms of retrograde loads during mobilization when one considers the fact that the ultimate purpose of the system is the efficient and effective delivery of ammunition to units in combat.

Stuffing of containers and designation of specific materials or equipment for the retrograde of ammunition containers would be a prime consideration at rear areas involved in large scale logistics operations in keeping with current or postulated concepts for the movement of materials and equipment to rear (support) areas. Containers, if unstuffed forward of areas of logistics operations, will probably be deadheaded (returned empty) to a logistics node. Otherwise, candidate loads in forward areas could include reusable dunnage, disposal materials, or other packing. Unserviceable ammunition could be returned; however, quantities would be minimal and more economical measures (expedient such as destruction) would be employed.

Candidate loads for the retrograde of containers out-of-theater or to CONUS could include all materials or equipment that are compatible with containerized shipment. The most obvious would be assemblies or sub-assemblies being retrograded for depot repair or rebuild. Excess supplies, especially Class IX items, could be retrograded in containers. Regardless of the type of materials, consideration must be given to the availability of resources required to secure the container loads, particularly if some type of reusable restraint system is not available.

The retrograding of containers by the industry is worthy of note. Despite not having to cope with the unusual requirements imposed by military mobilization, civilian industry retrogrades empties up to two and one-half times the number that are shipped with loads. The balance of trade makes this an unavoidable problem that is not world-wide but regional in nature. It is not unlikely that the same condition will prevail for military shipments during mobilization.

FINDINGS

1. Use of ISO containers for the intermodal shipment of goods and products in the commercial world has experienced unprecedented growth during the past decade. The only items presently not being shipped in containers to overseas destinations are large, bulky, heavy items, such as cement mixers, too large to fit into a container, and automobiles, although some automobiles are now shipped overseas in containers.

2. All major seaports throughout the world have been configured to rapidly handle containerized products with high-speed gantry cranes. The handling of break bulk by such seaports would be extremely time consuming and labor intensive. Major US shipping lines' executives have stated that they would refuse to handle general cargo in a break bulk mode except in very unusual circumstances and on an exception basis, i.e., low volume, high cost, or a national emergency.

3. Over 1.5 million TEU containers are owned by US leasing companies and foreign companies with headquarters in the United States. This compares with 2.4 million TEUs owned by US shipping lines. Currently, the military contracts with shipping lines for movement of military containerized cargo. There is little concern as to whether the shipping lines own their containers or lease them from a company because the cost of transportation to the Government is generally the same.

4. Since the quantity of break bulk shipments are so small, it was not possible to obtain comparative costs per ton for shipment of break bulk versus containerized cargo. However, representatives of four major shipping lines stated that the cost per ton of containerized cargo is significantly less than the cost per ton of break bulk for overseas shipments.

5. Although more than 50% of the world's current inventory of containers are 20 feet, there is a definite trend towards the use of 40-foot containers. This is due to the fact that approximately 85% of the general cargo shipped in containers normally cubes-out before it weights-out. Therefore, additional cube space reduces the cost of cargo shipped. Rates for movement of containers are by number of containers, not by tons shipped. It is estimated that sufficient quantities of 20-foot containers will remain in the system through the year 2000 for the movement of ammunition; however, with industry's apparent trend to 40-foot containers and the lack of interest in a side-opening container, other alternatives must be investigated to facilitate an efficient and effective ammunition logistics system in the far term.

6. Approximately 80% of the ammunition being shipped to Europe (400 containers per month) at the present time is shipped in MILVANS modified with a metal bar restraint system. The Army's current inventory of MILVANS consists of 4,000 modified for transport of ammunition and 1,559 unmodified. About 1% are unserviceable at any point in time. In the event of mobilization, it is estimated that the Army will run out of MILVANS during the first week of mobilization and will have to rely on the use of commercial ISO containers after that time.

7. As of 1984, only 1,237 side-opening containers out of a total of 1,733,576, or .07%, were available for use. Information from shipping lines and lessors of containers indicate that this number will grow smaller based on current container purchasing trends.

8. There are 280 container repair companies located in 39 countries of which 21 companies are in the US. Annual repairs range in size from 100 to 10,000 per year.

9. Flatracks offer a viable alternative to end-opening containers in that the flatrack is readily accessible for automated (robotic) unloading. They employ "O" or "D" rings in the base which facilitate securing of palletized ammunition with steel bands in lieu of costly and time consuming wooden dunnage. The flatrack ends can be folded inward, wherein four flatracks can be stacked in the same cube as one container.

10. Other alternatives that appear suitable for automated unloading of ammunition are the Palletized Loading System (PLS) and the side-opening containers currently under test by the US Air Force. Flatracks, PLS, and side-opening containers can be accommodated with very minor changes in the configuration of the current FMR workcell.

11. Bracing and blocking (dunnage) required for shipment of ammunition in an ISO container from a loading and packing plant or depot to and through a US port is costly to fabricate and install. It is labor intensive and is considered to be excessive by commercial packing and shipping industry standards.

12. Several alternatives to wooden dunnage appear feasible and worthy of further investigation. These include use of foams, pre-formed plastics, reusable light metal frames, and steel banding as well as systems such as IRSKIT and PALLA-GARD which considerably reduce wooden dunnage requirements.

13. Although several types of electronic systems are available on the market for tracking containers enroute and identifying the contents of a container, they are generally not being used by the container shipping industry.

The primary reason cited for this is the fact that the labor unions require a designated number of laborers assigned to container accountability functions as part of each crew. One of their functions is to check the seals on each container. They, therefore, can perform any other required inventory or container accountability functions at the same time, thereby making a separate electronic container tracking system unnecessary.

APPENDIX A

REFERENCES

REFERENCES

An Optimization Study of Cargo Container Sizes for Shipment of Ordnance, Naval Ammunition Depot Earle, Colts Neck, New Jersey February 1972.

Baltimore Port Fact Book, Maryland Port Administration, Baltimore, Maryland

Baltimore Shipping Services, Maryland Port Administration, Baltimore, Maryland

CADS ISO Container Survey, Headquarters, US Air Force, Letter, Washington, DC September 21, 1985

Cargo Restraint, Automatic Truckloading Systems, Inc., TELECON, November 27, 1985

Cargo Restraint, N.P. Marketing Corporation, Neenah, Wisconsin, Letter, November 27, 1985

Cargo Restraint, N.P. Marketing Corporation, TELECON, November 27, 1985

Cargo Restraint, Peck and Hale, Inc., TELECON, November 27, 1985

Carriage of Munitions in Intermodal Container Units, US Naval Sea Systems Command, Washington, DC, Letter, November 20, 1985

Commander, Troop Support Command, Message, MILVAN Specification, November 27, 1985

Container Acquisition in the Navy, R. C. Lawrence, Naval Postgraduate School, Monterey, California, December 1982

Container Data Assessment, Headquarters, Tobyhanna Army Depot, Tobyhanna, Pennsylvania, Letter, October 22, 1985

Container Leasing Survey, Flexi-Van Leasing, Inc., Lyndhurst, New Jersey, Letter, November 26, 1985

Container Leasing Survey, Institute of International Container Lessors, Bedford, New York, Letter, November 14, 1985

Container Management, Flexi-Van Leasing, Inc., Lyndhurst, New Jersey, Letter, January 3, 1986

Container Management, Star Publishing, Isleworth, UK, December 1985

Container News, Communications Channels, Inc., Atlanta, Georgia, May through October 1985

Container Operations, Institute of International Container Lessors, TELECON, November 13 and 22, 1985

Container Operations, International Terminal Operating Company and ASI Conference, Baltimore, Maryland, November 18, 1985

Container Operations, Maryland Port Administration, and ASI Conference, Baltimore, Maryland, November 14, 1985

Container Operations, Sea-Land Services, Inc., and ASI Conference, Baltimore, Maryland, November 18, 1985

Container Operations, US Lines, Inc., and ASI Conference, Baltimore, Maryland, November 14, 1985

Container System Hardware Status Report, US Army Troop Support Command, Belvoir R&D Center, Fort Belvoir, Virginia, January 1985

Container Stuffing Operations, Baltimore Packaging, Borg-Warner-York and ASI Conference, Baltimore, Maryland, November 18, 1985

Container Survey, Headquarters, US Air Force, Washington, DC, Letter, October 29, 1985

Container Survey, US Army Defense Ammunition Center and School, Savanna, Illinois, Letter, October 22, 1985

Container Survey, US Naval Supply Systems Command, Washington, DC, Letter, November 4, 1985

Containerized Shipment and Storage of Ammunition (COSSA) Study, Headquarters, US Army Training and Doctrine Command, Fort Monroe, Virginia, November 1977

Containerized Shipment and Storage of Ammunition (COSSA) Study, 1977-1986, Headquarters, US Army Training and Doctrine Command, Fort Monroe, Virginia, November 1977

Criteria for Inspection of the US Army MILVAN Container for Ammunition Shipments, Report Number EVT 7-76, DARCOM Ammunition Center, Savanna, Illinois, Undated

Deputy Director, Port Sales and Marketing, Port of Baltimore, Maryland, November 22, 1985

Field Logistics System, Status Report, Headquarters, US Marine Corps, Washington, DC, December 1982

Foamed-in-Place Blocking of Containerized Ammunition, Road and Tilt Test, Progress Report Number 7-70, AMC Ammunition Center, Savanna, Illinois, June 24, 1970

Foreign Commerce Statistical Report, 1984, Maryland Department of Transportation, Maryland Port Administration, Baltimore, Maryland

Foreign Commerce Statistical Report, 1984, Maryland Port Administration, Baltimore, Maryland

Freight Containers in Intermodal and Land Bridge Commerce, J. S. Walters, Naval Post Graduate School, Monterey, California, September 1980

FY 81, Third and Fourth Quarter Progress Report of the Prestaged Ammunition Loading System (PALS), Report Number EVT 10-78, US Army Defense Ammunition Center and School, Savanna, Illinois, Undated

Human Engineering Laboratory (HEL) Contractor for Field Materiel Handling Robotics (FMR) Program, US Army Defense Ammunition Center and School, Savanna, Illinois, Letter, January 31, 1986

Identification of Parameters for a Pre-Staged Ammunition Loading System, US Army Mobility Equipment Research and Development Command, Fort Belvoir, Virginia, January 5, 1978

Impact on Military Containerization of a Trend by the Civilian Section Towards 40-Foot Containers (The), P. R. Neshiem, Naval Postgraduate School, Monterey, California, December 1984

International Registry of Trailer, Container and Chassis Equipment, Intermodal Transportation Association, Riverdale, Maryland, August 15, 1985

Inventory of American Intermodal Equipment, 1984, Department of Transportation, Washington, DC, May 1984

ISO Containers for Ammunition, US Army Belvoir Research and Development Center, Fort Belvoir, Virginia, Letter, September 27, 1985

Jane's Freight Containers, 1985, Jane's Publishing Company, Ltd., New York, New York, 1985

Joint Logistics Over-the-Shore II (JLOTS II), Operational Test Report, DoD Joint Test Director, Norfolk, Virginia, March 1, 1985

Kraus, K. L., LTC, USA, "Pass the Ammunition", TRANSLOG, July 1982

Loading and Bracing with Wooden Dunnage in Commercial Containers of Boxed Ammunition and Components on 4-Way Entry Pallets and Skid Bases, US Army Development and Readiness Command, Alexandria, Virginia, July 1981

Loading and Bracing with Wooden Dunnage in Commercial Containers of Palletized Units of Separate Loading Projectiles, US Army Development and Readiness Command, Alexandria, Virginia, December 1980

Logistics-Over-the-Shore (LOTS) Interface Systems Analysis, Main Report, Belvoir Research and Development Center, Prepared by the BDM Corporation, McLean, Virginia, March 1984

Maryland Port Administration Rates, Rules and Regulations, Baltimore, Maryland, September 24, 1985

MSC Container Agreement and Rate Guide, Military Sealift Command, Washington, DC, October 1, 1985

Official Intermodal Equipment Register (The), Intermodal Publishing Company, Ltd., New York, New York, December 1985

155MM Separate Loading Projectiles in a MILVAN Container, Report Number EVT 28-74, AMC Ammunition Center, Savanna, Illinois, June 4, 1974

Port of Baltimore, Maryland Port Administration, Baltimore, Maryland, October 1985

Quatrevaux, E. R., MAJ, US Army, "Transportation Unit Productivity Improved", Army Logistician, Fort Lee, Virginia, November-December 1983

Rail Impact Test, Mechanical Bracing, Progress Report 13-66, AMC Ammunition Center, Savanna, Illinois, October 5, 1966

Readiness and Implementation Study for a Reusable Ammunition Restrain System in Commercial Intermodal Containers, Naval Weapons Handling Center (NWHC), Colts Neck, New Jersey, January 22, 1979

Restraint of Ammunition in the ISO Commercial Container, Utilizing the Type "A" Insert Kit, Progress Report Number EVT 1-75, AMC Ammunition Center, Savanna, Illinois, Undated

Restraint of Ammunition in the ISO Commercial Container Utilizing the Type "B" Insert Kit (Brooks and Perkins, Inc., System), Progress Report Number EVT 17-75, AMC Ammunition Center, Savanna, Illinois, Undated

Restraint of Ammunition in Commercial ISO Containers Utilizing Wood Dunnage, Report Number EVT 3-75, AMC Ammunition Center, Savanna, Illinois, Undated

Schoch, B. P., "Organization for Fast-Break", Army Logistician, Fort Lee, Virginia, January-February 1986

Shipping Container Information, US Army Armament, Munitions and Chemical Command, Letter, December 18, 1985

Survey Report on the Status of Container Integration in the Army Supply System, US Army Mobility Equipment Research and Development Command, Fort Belvoir, Virginia, March 1983

Terminal Services Tariff Number 9, Maryland Port Administration, Baltimore, Maryland, October 1, 1985

Trial Shipment of Live Ammunition in Commercial Intermodal 20-Foot Containers Utilizing the Navy Internal Restraint System (IRSKIT), Report Number EVT 8-78, US Army Defense Ammunition Center and School, Savanna, Illinois, Undated

Trial Shipment of Live Ammunition in Commercial Intermodal 20-Foot Containers Utilizing Wooden Dunnage for Restraint, Report Number EVT 77-2, DARCOM Ammunition Center, Savanna, Illinois, Undated

Trial Shipment of Ammunition in Commercially Owned 20-Foot Intermodal Containers Utilizing Wooden Dunnage for Restraint, US Army DACS Report Number EVT 4-79, Savanna, Illinois

Trial Shipment of Four Commercial Intermodal 20-Foot Containers from Savanna Depot Activity and Naval Weapons Station Earle, to Miesau Army Depot, Germany, and Return, DARCOM Ammunition Center, Savanna, Illinois, Undated

US Army Defense Ammunition Center and School, SMCAC-DEV, Savanna, Illinois, Letter, January 31, 1986

Worldwide Army Ammunition Review, Headquarters, US Army Armament, Munitions and Chemical Command, Rock Island, Illinois, December 12, 1985

Wright, V. J., "Ammo Support in Europe", Ordnance Magazine, US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, Summer 1985

APPENDIX B

Glossary of Terms and Abbreviations

Glossary of Terms and Abbreviations

ALS	Automatic Loading System.
ANSI	American National Standards Institute.
ASI	Armament Systems, Inc.
Break Bulk	Loose or non-containerized.
COFC	Container on Flat Car (Operations).
Companies (Container Industry)	
APL	American President Lines, Ltd.
Farrell	Farrell Lines, Inc.
Flexi-Van	Flexi-Van Leasing, Inc.
ITEL	Itel Containers International Corporation.
ITO	International Terminal Operating Company, Inc.
Sea Containers	Sea Containers Agencies, Inc.
Sea-Land	Sea-Land Services, Inc.
TOL	Trans Ocean, Ltd.
TRANSAMERICA	TransAmerica Transportation Services, Inc.
U.S. Lines	United States Lines, Inc.
XTRA	XTRA, Inc.
CONUS	Continental United States.
Cube Out	Reach the cubic foot (load) capacity.
DACS	Defense Ammunition Center and School.
Demurrage	A charge for detaining a ship, freight car or truck.
DROPS	Demountable Rack Off-Load and Pickup Systems (also known as PLS).
Dunnage	Materials used around a cargo to prevent damage.
FEU	Forty-foot Equivalent Unit.
Flatrack	An open-side, open-top platform with or without end frames or end ramps that fold inward or outward.
FMR	Field Materiel Handling Robot.
Foamed-in-Place Blocking	Bags (polyethylene) of polyurethane foam used to block and brace unitized ammunition in a standard 20'x8'x8' container.

Half-Height	Used to refer to containers or flatracks that are less than the ISO standard (8' or 8'6") in height. Normally about 4' high.
HEL	US Army Human Engineering Laboratory.
IICL	Institute of International Container Lessors.
Intermodal	As used in this report (shipment; transfer): between two or more modes of transportation.
IRSKIT	Internal Restraint System Kit.
ISO	International Standardization Organization.
ITO	International Terminal Operating Company, Inc.
JIT	Just-in-time.
Lashing Ring	"O" or "D" shaped rings used as tie-down (securing) points for cables or steel banding that is used to secure cargo.
LOGMARS	Logistics Applications of Automatic Marking and Reading Symbols.
LPRS	Loose Projectile Restraint System.
Measurement Ton	Forty cubic feet.
MILVAN	Military Van.
MPA	Maryland Port Administration.
MSC	Military Sealift Command.
MTMC	Military Transportation Management Command.
OCONUS	Outside the continental United States.
Open Side	Having accessability for stuffing and unstuffing from the side with no door closures.
PALLA-GARD	Commercial System (N. P. Marketing Corp.) for container cargo restraint.
PALS	Pre-staged Ammunition Loading System.
PLS	Palletized Loading System (also known as DROPS).
PM AMMOLOG	Project Manager, Ammunition Logistics.

ROC	Required Operational Capability.
RO-RO	Roll-on, Roll-off operations involving the use of specially designed ships for rolling stock.
Seavan	Commercial dry van.
Side Opening	Having accessability for stuffing and unstuffing from the side with door closures.
Slip Sheet	A thin, plastic sheet used for the rapid extraction of cargo from a container.
Stuff	Load cargo into (a container).
TEU	Twenty-foot Equivalent Unit.
TOFC	Trailer on Flat Car (operations).
Unstuff	Unload cargo from (a container).
Weigh-out	Reach the weight (load) capacity.

APPENDIX C

TERMINOLOGY RELATING TO FREIGHT CONTAINERS

TERMINOLOGY RELATING TO FREIGHT CONTAINERS

A. Definitions-General

1. Freight Container

Article of transport equipment

a. of a permanent character and accordingly strong enough to be suitable for repeated use;

b. specially designed to facilitate the carriage of goods by one or more modes of transport, without intermediate reloading;

c. fitted with devices permitting its ready handling, particularly its transfer from one mode of transport to another;

d. so designed as to be easy to fill and empty;

e. having an internal volume of 1 m^3 (35.3 ft^3) or more.

The term freight container includes neither vehicles nor conventional packing.

B. Container Types

1. General container types are grouped and groups are subdivided according to the following concepts: mode of transport, categories of cargo and the physical characteristics of the container. Thus:

- It is assumed that containers are intended for use in any or all of the surface modes of transport, i.e., road, rail and sea, unless otherwise stated. Only in the case of containers primarily intended for transport by air (air mode containers) is any specific reference made to the mode of transport when classifying ISO types of containers.

- The main classification is made in terms of the type of cargo for which a container is primarily intended.

General cargo containers include those containers which are temperature sensitive, for liquids and gases, for dry solids in bulk and for particular categories such as automobiles (cars), or livestock. This group is subdivided according to the appropriate physical attributes of the container.

2. Type codes. Container type codes are given in ISO 6346. The type code consists of two arabic numerals, the first of which indicates the category and the second of which indicates certain physical characteristics or other attributes.

NOTE: Neither the summary, nor the definitions which follow it, is intended to constitute an exhaustive list of container types. When type codes are quoted with definitions, they are given as typical examples only.

3. *Definitions of container types*

a. General cargo container. This is a general term applicable to any type of container which is not intended for use in air mode transport and which is not primarily intended for the carriage of a particular category of cargo such as a cargo requiring temperature control, a liquid or gas cargo, dry solids in bulk or cargoes such as automobiles (cars) or livestock.

b. General purpose container. (See ISO 1496/1) Freight container, totally enclosed and weather-proof, having a rigid roof, rigid side walls, rigid end walls and a floor, having at least one of its end walls equipped with doors and intended to be suitable for the transport of cargo of the greatest possible variety. The simplest form of this type of container is given the type code 00. A general purpose container having an opening roof may be used for the same specific purpose as an open top container. Such a container is given type code 03.

c. Specific purpose container. This is a general term applicable to all general cargo containers having constructional features either for the "specific purpose" of facilitating packing and emptying other than by means of doors at one end of container, or for other specific purposes such as ventilation. The container types covered by this general term are those defined below from closed ventilated container to platform (container) inclusive.

d. Closed vented/ventilated container. Container similar to a general purpose container of the closed type but designed to allow air exchange between the interior of the container and the outside atmosphere.

e. Vented container. Container provided with passive vents at the upper part of its cargo space. Vented containers have the following type codes:- 10 for those having vents of a total cross-sectional area of less than $25cm^2$ per metre of nominal length of containers; - 11 for those having vents of a total cross-sectional area of greater than or equal to $25cm^2$ per metre of nominal length of containers.

f. Ventilated container. Container provided with a ventilating system designed to accelerate and increase the natural convection of the atmosphere within the container as uniformly as possible. Ventilated containers have the following type codes: - 13 for those provided with a non-mechanical ventilating system consisting of vents provided at both the lower and upper parts of their cargo space; - 15 for those provided with a mechanical ventilating system located internally; - 17 for those provided with a mechanical ventilating system located externally. (NOTE: Cross-sectional area is the smallest cross-section of area of the air passage between the outside and the inside.)

g. Open top container (See ISO 1496/1). Freight container similar in all respects to a general purpose container except that it has no rigid roof but may have a flexible and movable or removable cover, for example, one made of canvas or plastic or reinforced plastic material normally supported on movable or removable roof bows. Such containers may have movable or removable top end transverse members above their end doors.

h. Platform based container open sided. This is a general term applied to any general cargo container which does not have rigid side walls or equivalent structures capable of withstanding all of the loads that may be withstood or transmitted by a side wall of a general purpose container and which, for this reason, has a base structure similar to that of a platform (container). The main sub-types covered by this general term are as follows:

(1) Platform based container open sided with complete superstructure (see ISO 1496/6 c). Platform-based container, having a permanently fixed longitudinal load-carrying structure between ends at the top. The term load as used refers to a static/dynamic type load, not a cargo load. Containers of this type have the following type codes: 65 for those having a rigid roof and rigid end walls (open sided); 54 for those having an open top and rigid end walls; 55 for those having an open top and open ends (skeletal).

(2) Platform based containers with incomplete superstructure and fixed ends (see ISO 1496/6 a). Platform based container without any permanently fixed logitudinal load-carrying structure between ends other than at the base. Containers of this type have type codes 61 and 62.

(3) Platform based container with incomplete superstructure and folding ends. Platform based container with incomplete superstructure but having folding end frames with a complete transverse structural connection between corner posts. Containers of this type have type codes 63 and 64.

(4) Platform (container) (see ISO 1496/5). Loadable platform having no superstructure whatever but having the same length and width as the base of a container of the same series and equipped with top and bottom corner fittings, located in the plan view as on containers of series 1, so that some of the same securing and lifting devices can be used. Containers of this type have type code 60.

i. Specific cargo containers. This is a general term applied to those types of containers which are primarily intended for the carriage of particular categories of cargo.

(1) Thermal container (see ISO 1496/2). Freight container built with insulating walls, doors, floor and roof which retard the rate of heat transmission between the inside and the outside of the container.

(2) Insulated container. Thermal container without the use of devices for cooling and/or heating. Containers of this type have type codes 20 and 21.

(3) Refrigerated container (expendable refrigerant). Thermal container using a means of cooling such as: ice, or; dry ice, with or without sublimination control, or; liquefied gases, with or without evaporation control. It is implicit in this definition that such a container requires no external power supply or fuel supply. Containers of this type have type code 30.

(4) Mechanically refrigerated container. Thermal container served by refrigerating appliance (mechanical compressor unit, absorption unit, etc.). Containers of this type have type code 31.

(5) Heated container. Thermal container served by heat-producing appliance. Containers of this type have type code 22.

(6) Refrigerated and heated container. Thermal container served by refrigerating appliance (mechanical or expendable refrigerant) and heat producing

appliance. Containers of this type have type code 32.

(7) Tank container (see ISO 1496/3). A freight container which includes two basic elements, the tank or tanks and the framework, and complies with the requirements of ISO 1496/3. Containers of this type have type codes 70 to 79.

(8) Dry bulk containers (provisional definition). Container consisting of a cargo-carrying structure, firmly secured within an ISO Series 1 framework, for the carriage of dry solids in bulk without packaging. Containers of this type have type codes 80 and 81.

(9) Named cargo types. Various types of containers such as automobile (car) containers, livestock containers and others, are built in general accordance with ISO container requirements either solely or primarily for the carriage of a named cargo. Type code numbers have been allocated to cattle carriers (85) and automobile carriers (86) and spare numbers exist for other 'named cargo types'.

j. Air mode containers.

(1) Air container: Any freight unit load device, primarily intended for transport by air, having an internal volume of $1m^3$ ($35\text{-}3ft^3$) or more, incorporating restraint provisions compatible with an aircraft restraint system, and an entirely flush base bottom to allow handling on rollerized cargo handling systems.

(2) Air/surface (intermodal) container: An article of transport equipment having an internal volume of $1m^3$ ($35\text{-}3ft^3$) or more, fitted with top and bottom corner fittings, with restraint provisions compatible with an aircraft restraint system, and an entirely flush base bottom to allow handling on rollerized cargo handling systems. The container is primarily intended for transport by air and interchange with surface transport modes (road, rail and sea). Containers of these types have type codes 90 to 99.

C. Container Characteristics

1. Series designations. Three series of containers have been studied by ISO. Each series of containers was intended to cover containers having dimensional relationships one with another but not with containers of other series. Series 1 containers are intended for intercontinental use. Series 2 containers were intended for internal continental systems but owing to steadily declining use, this series is no longer covered by International Standards. Series 3 containers were intended essentially for internal continental systems and will in the future be covered by an ISO Technical Report.

2. Size designations. For Series 1 containers, the size designations are given in Table 1.

Table C-1 Size Designations.

Nominal Length		Nominal Height		
m	f	2,438mm (8 ft)	2,591mm (8-5ft)	Less than 2,438mm (8ft)
12	40	1 A	1 AA	1 AX
9	30	1 B	1 BB	1 BX
6	20	1 C	1 CC	1 CX
3	10	1 D	—	1 DX

All units have a nominal width of 2,438mm (8ft).

3. Container size codes. Size codes are given in ISO 6346. The size code consists of two arabic numerals. For containers having a nominal length equal to or greater than 3,000mm (10ft), the first numeral denotes length and the second numeral denotes height and the presence or absence of a gooseneck tunnel.

D. Definitions Related to Dimensions and Capacities

1. External dimensions.

a. Nominal dimensions. Those dimensions, neglecting tolerances and rounded to the nearest convenient figure, by which a container may be identified. They are given in ISO 668 and are commonly quoted in imperial units.

b. Actual dimensions. Maximum overall external dimensions (including positive tolerances where these are applicable) for length, width and height measured along the exterior edges of the container. Diagonal tolerances, applicable to any of the six "faces" of a container are expressed in terms of the allowable difference between the lengths of the diagonals (measured between the centres of the corner fitting apertures) of the face in question. These diagonal tolerances are allowable even when the edge dimensions for the surface in question are at their maximum values.

2. Internal dimensions. These are the dimensions of the largest unobstructed rectangular parallelepiped which could be inscribed in the container if inward protrusions of the top corner fittings are neglected. Except where otherwise stated, the term "internal dimensions" is synonymous with the term "unobstructed internal dimensions". Some requirements governing internal dimensions are given in ISO 1894 and in ISO 1496/1 and ISO 1496/2.

3. Door opening. This term is usually reserved for the definition of the size of the (end) door aperture, i.e., the width and height dimensions of the largest unobstructed parallelepiped which could possibly be entered into the container via th door aperture in question. Minimum door openings are prescribed in ISO 1496/1 for some general purpose containers. NOTE: See definition of "opening" below.

4. Internal volume. Volume determined by multiplying the internal dimensions, i.e., the product of internal length, width and height. Except when otherwise stated, the term "internal volume" is synonymous with the terms "unobstructed internal volume", "capacity", or "unobstructed capacity".

E. Definitions Related to Ratings and Masses

The term "weight" is still widely (but incorrectly) used instead of the form "mass".

1. Rating (R). This is the maximum permissible combined mass of the container and its contents, i.e., the maximum operating gross mass. Ratings are given in ISO 668.

2. Tare mass (T). Mass of empty container including all fittings and appliances associated with a particular type of container in its normal operating condition, i.e., in the case of a mechanically refrigerated container with its refrigeration equipment installed and, where appropriate, full of fuel. The term

"tare" is synonymous with the term "tare mass" and the more commonly (but incorrectly) used term "tare weight".

3. Payload (P). Maximum permitted mass of payload (including such cargo securement arrangements and/or dunnage as are not associated with the container in its normal operating condition); determined by subtracting tare mass (T) from rating (R).

F. Definitions Related to Capabilities

The "capabilities" defined below are by no means all of the capabilities of containers of different types but are those capabilities deemed to require definition.

1. Stacking capability. Ability of a container to support a certain number of fully loaded containers of the same nominal length and the same rating under the acceleration conditions encountered in ship cell structures, taking into account relative eccentricities between containers due to cell structure clearances.

2. Restraint capability. Ability of a container to withstand those longitudinal accelerations which may be encountered in service when a container is secured by features in its base structure to an item of transport equipment.

3. Floor loading capability. In general, using the term "floor loading" signifies the static or dynamic loading imposed by the payload or by wheeled equipment used to pack or empty the container. But in the context of freight container testing, the term is used to indicate the ability of a container floor to withstand loads imposed by wheeled equipment having defined characteristics.

4. Rigidity. Ability of a container to withstand either transverse or longitudinal racking loads of stated amounts, resulting particularly from ship movement.

5. Weatherproofness. Ability to withstand a defined weather-proofness test.

G. Definitions Related to Container Components and Structures

1. Corner fittings. Fittings at the corners of containers providing means of supporting, stacking, handling, and securing the container.

2. Top end transverse member. Transverse structural member at the top of an "end frame" of a container joining the top corner fittings of the end in question. Where mounted above end doors, these members are commonly known as "door headers", and in open top containers such headers are often movable ("swinging" or "hinged") and sometimes completely removable. Platform based containers with free standing (corner) posts do not have top end transverse members.

3. Bottom end transverse member. Transverse structural member at the bottom of an "end frame" of a container joining the bottom corner fittings of the end in question. Where mounted below end doors, these members are commonly known as "door sills".

4. Top side rail. Longitudinal structural member at the top of a side of a container joining top corner fittings of the side in question. In platform based containers which are open sided and open top, these longitudinal members may be

removable, and are not necessarily intended to take longitudinal loadings. In open top containers, they may be used to support removable (or sliding) roof bows, which, in turn, support a canvas or plastic cover.

5. Bottom side rail. Longitudinal structural member at the bottom of a side of a container joining the bottom corner fittings of the side in question.

6. Corner post. Vertical structural member at either side of an "end frame" of a container joining a top and a bottom corner fitting (and thereby forming a "corner structure").

7. Floor. Component supporting payload of container. Component generally constructed from a number of planks or panels. In certain categories of thermal containers, floor components may be especially designed to allow air (or gas) to be passed underneath the cargo.

8. Floor bearers. Components in the "base structure" of a container supporting the floor. In general cargo containers, such components are commonly laid transversely. In such cases they are also known as "cross members" or "intermediate transverse members", i.e., transverse members in the base structure, intermediate between the "bottom end transverse members" in the "end frame". In platform based containers, transverse floor planking is sometimes supported on additional longitudinal members, in which case these may also be regarded as floor bearers.

9. Roof bows. Members mounted transversely across the top of a container and either forming part of a rigid roof structure or supporting flexible, removable covers in which case the members are commonly removable, or so designed as to slide to facilitate the loading of cargo through the top of the container.

10. Fork (lift) pockets. Reinforced pockets running transversely across the "base structure" of a freight container piercing the bottom side rails are prescribed positions to permit the entry of the tines of fork lift devices for lifting and carrying the container.

11. Grappler arm lifting areas. Recesses in the bottom side rails of a container having specified features to permit the use of grappler arms for lifting and carrying the container.

12. Goose-neck tunnel. Recess at one end (commonly the "front" end) of the container designed to accommodate the raised portion of a goose-necked chassis. In certain types of containers, goose-neck tunnels are fitted at each end.

13. Opening. Aperture closed by a movable or removable panel of a container designed as a load bearing structure and also to be weatherproof and reasonably airtight. The term "open" is a description applied where one or more of the sides, ends or the roof of a container is permanently open. This description is still applicable even when flexible covers are provided.

a. End door. Load bearing panel located in an end wall, arranged to open or close an aperture having prescribed minimum width and height.

b. Side door. Load bearing panel located in a side wall, arranged to open or close an aperture of unspecified dimensions but at least big enough to allow a man to walk through.

c. Covers. Flexible, removable sheets (such as sheets of canvas, plastic or plastic coated cloth) usually intended to provide a weatherproof closure to an open top, side and/or end of a container.

14. Structures.

a. Base structures. Rigid assembly in which the components most commonly found are:

(1) four bottom corner fittings;

(2) two bottom side rails;

(3) two bottom end transverse members;

(4) a floor and floor bearers (except in tank types);

(5) such optional features as fork lift pockets, grappler arm lifting areas and/or a goose-neck tunnel.

See note under "end frame". Base structures also include load transfer areas. Thes are at prescribed positions to allow for load transfer between the container and a carrying vehicle. The term "base" is sometimes used as a synonym for the term "base structure".

b. Platform based. Term applied to deep base structures similar to the structures of platform (containers) necessary in containers without side walls, i.e. open sided.

c. End frame. Assembly at either end of a container consisting of two top and two bottom corner fittings, two corner posts and a top and a bottom transverse member. This commonly used term overlaps with the term "base structure" to the extent that the bottom corner fitting and the bottom end transverse member appear in both. The term also includes the term "corner structure" — an assembly consisting of a top and a bottom corner fitting and a corner post. Caution should be used in the employment of these terms to avoid possible confusion.

d. End wall. End closure of a freight container bounded by and affixed to, but not including the end frame. This is assumed, unless otherwise stated, to be fully load bearing to the minimum extent required for the type of container in question. Reference to "equivalent structures" means structures having the same strength as end walls but not necessarily having the same weather-proofness. Reference is sometimes made to the "rear" or "front" end of a container. The "rear" end is normally taken to mean the door end and the "front" end is taken to mean the end opposite to the door end. Such terms should be avoided where a container has similar ends if it is necessary to differentiate between the two ends then this should be done by reference to some feature which clearly distinguishes one end from another (for example, features such as markings, plates, discharge facilities, etc.).

e. Side wall. Side closure of a freight container bounded by and affixed to, but not including, top and bottom side rails or corner structures. (See note under end frame.) Side walls are assumed, unless otherwise stated, to be load bearing to the minimum extent required for the type of container in question.

Reference to "equivalent structures" means structures having the same strength as side walls but not necessarily the same weather-proofness. The term "side frame" is occasionally used, but since it cannot be defined without considerable overlap with the much more commonly used terms "end frame" and "base structure", its use is to be discouraged except for tank containers.

f. Roof. Rigid weatherproof structural assembly forming the top closure of a container, bounded and supported by the top end transverse members and the top side rails. Although rigid assemblies, roofs may in some cases be removable.

H. Definitions Applicable to Certain Container Types

1. Thermal containers.

a. Removable equipment. Refrigerating and/or heating appliance which is designed primarily for attaching to or detaching from the (thermal) container when transferring between different modes of transport.

b. Located internally. Totally within the external dimensional envelope of the (thermal) container as defined in ISO 668.

c. Located externally. Partially or totally outside the external dimensional envelope of the (thermal) container as defined in ISO 668. It is implicit in this definition that an appliance located externally must be removable or retractable to allow or facilitate transport in certain modes.

d. Battens. Members protuding from the inside walls of the (thermal) container to hold the cargo away from the walls to provide an air passage. They may be integral with the walls, fastened to the walls, or added during cargo handling.

e. Bulkhead. A partition in a (thermal) container providing a plenum chamber and/or air passage for either return or supply air. It may be an integral part of the appliance or a separate member.

f. Ceiling air duct. A passage or passages in a (thermal) container located in proximity to the ceiling to direct air flow.

g. Floor air duct. A passage or passages in a (thermal) container located beneath the cargo support surfaces to direct air flow.

2. Tank containers.

a. The tank mountings, end structure and all loadbearing elements not present for the purposes of containing cargo, which transmit static and dynamic forces arising out of the lifting, handling, securement and transporting of the tank container as a whole.

b. Tank or tanks. The vessel or vessels, and associated piping and fittings which are designed to confine the goods carried.

c. Compartment. Any fluid-tight section of the tank formed by the shell, ends or bulk-heads. It should be noted that baffles, surge plates or other perforated plates do not form tank compartments within the meaning of this definition.

d. Gas. Gas or vapour having a vapour pressure greater than 3 bar[1]) absolute at 50°C or as otherwise defined by the competent authorities.

e. Liquid. Fluid substance having a vapour pressure not greater than 3 bar[1]) absolute at 50°C.

SOURCE: Jane's Freight Containers, 1985.

APPENDIX D

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POINTS OF CONTACT

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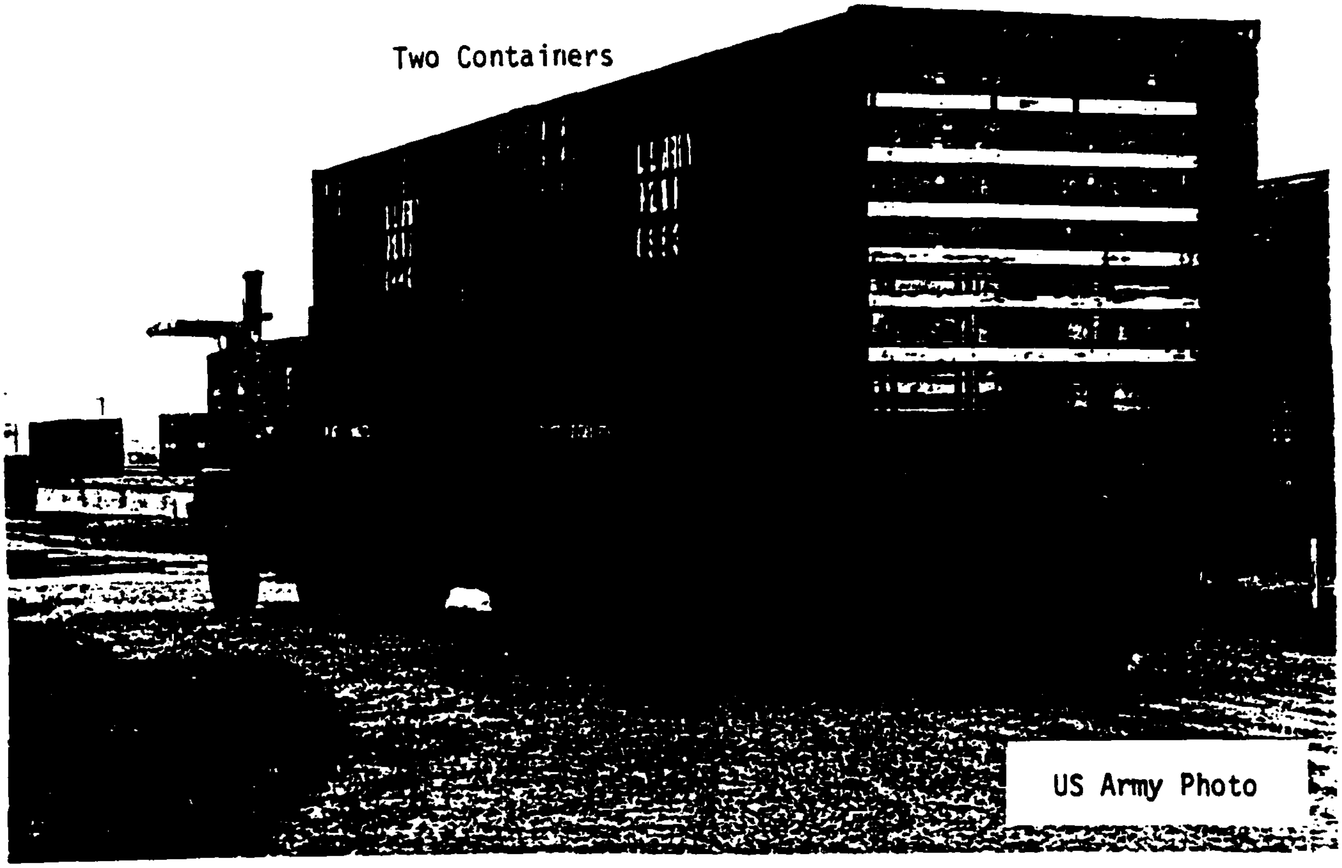
APPENDIX E

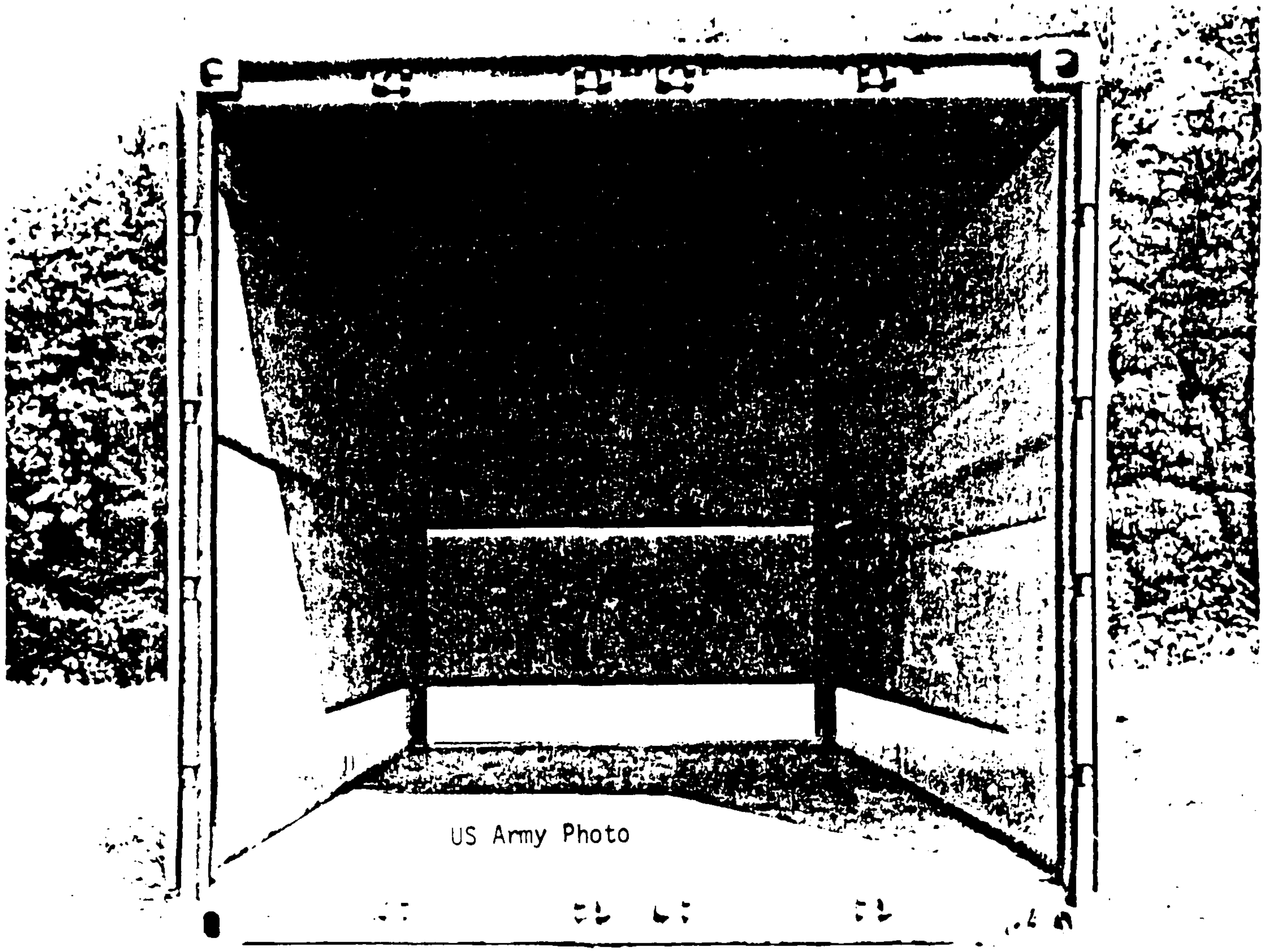
CONTAINER PHOTOGRAPHS AND DATA SHEETS



1. Designation: MILVAN(Type II) Ammunition Restraint
2. Dimensions (LxWxH):
   External: 20'x8'x8'
   Internal: 19'4"x7'7.5"x7.3"
3. Type Opening: Rear Door
   Dimensions (Internal WxH): 7'5"x7'
4. Weight in Pounds:
   Tare: 5,785 (Includes 1,300 pound restraint system)
   Payload: 39,015
5. Designed for Ammunition: Yes
6. Integral Restraint System: Mechanical
7. Restraint Required: Filler Dunnage
8. Used for Ammunition/Type: Yes/All
9. Availability: Inventory
10. US Flag Quantity: 4,000
11. US Army, Tobyhanna
12. Special MHE: None
13. Data Source: DACS, BRDEC, Tobyhanna

PHOTOGRAPH NOT AVAILABLE
(See Page E-2 for a photograph of the eight foot high Type II MILVAN.)

1. Designation: MILVAN(Type II) Ammunition Restraint
2. Dimensions (LxWxH):
   External: 20'x8'x8'6"
   Internal: 19'4"x7'5.5"x7'9"
3. Type Opening: Rear Door
   Dimensions (Internal WxH): 7'5"x7'6"
4. Weight in Pounds:
   Tare: 5,785 (Includes 1,300 pound restraint system)
   Payload: 39,015
5. Designed for Ammunition: Yes
6. Integral Restraint System: Mechanical
7. Restraint Required: Filler Dunnage
8. Used for Ammunition/Type: Yes/All
9. Availability: FY 86 Buy
10. US Flag Quantity: 578
11. Owner: US Army, Tobyhanna
12. Special MHE: None
13. Data Source: DACS, BRDEC, Tobyhanna



US Army Photo

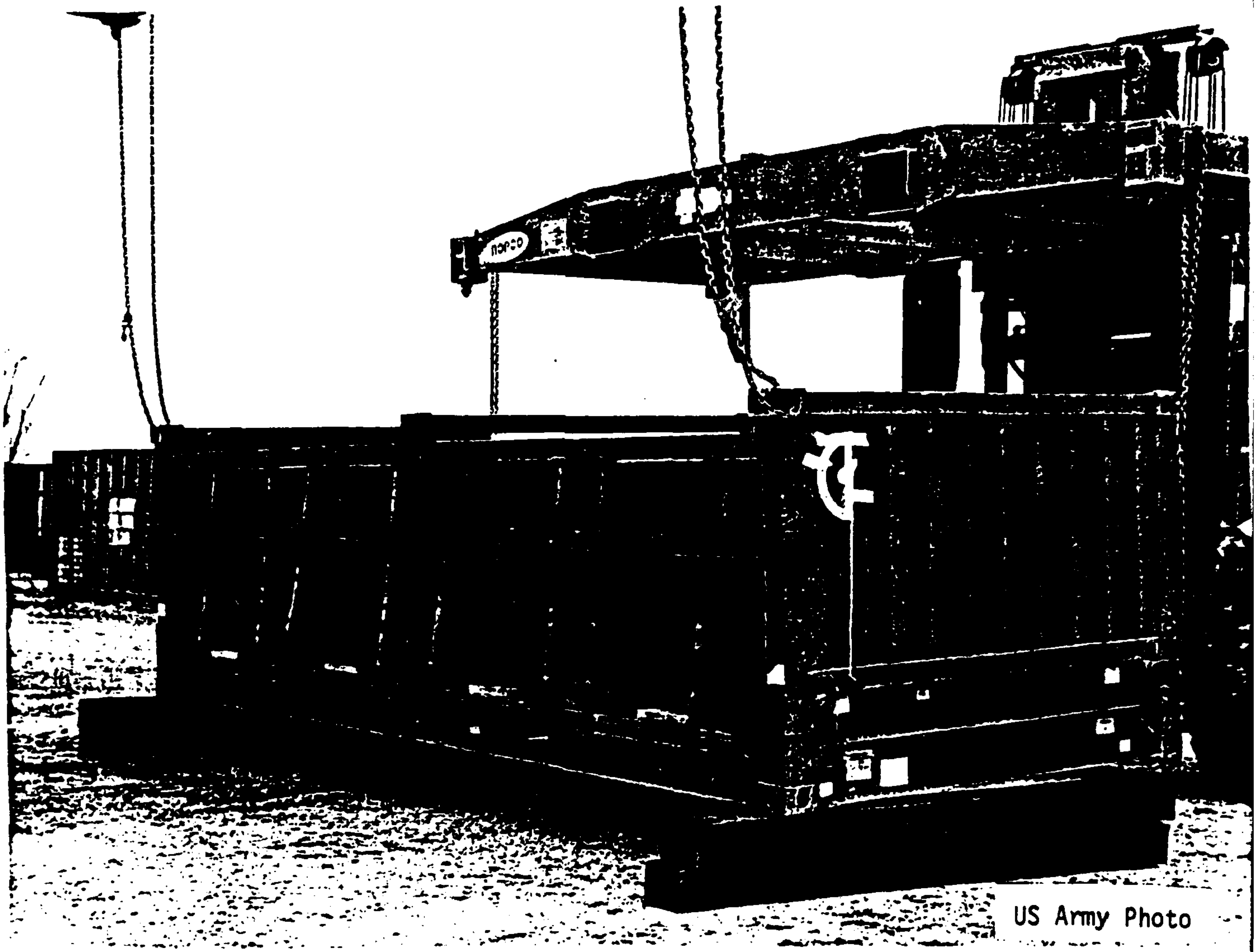
1. Designation: MILVAN(Type I)General Cargo
2. Dimensions (LxWxH):
   External: 20'x8'x8'
   Internal: 19'4"x7'8"x7'3"
3. Type Opening: Rear Door
   Dimensions (Internal WxH): 7'5"x7'
4. Weight in Pounds:
   Tare: 4,700
   Payload:40,100
5. Designed for Ammunition: No
6. Integral Restraint System: None
7. Restraint Required: Yes, Blocking and Bracing
8. Used for Ammunition/Type: No(on exception)
9. Availability: Inventory
10. US Flag Quantity: 1,559
11. Owner: US Army, Tobyhanna
12. Special MHE: None
13. Data Source: DACS, BRDEC, Tobyhanna

DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

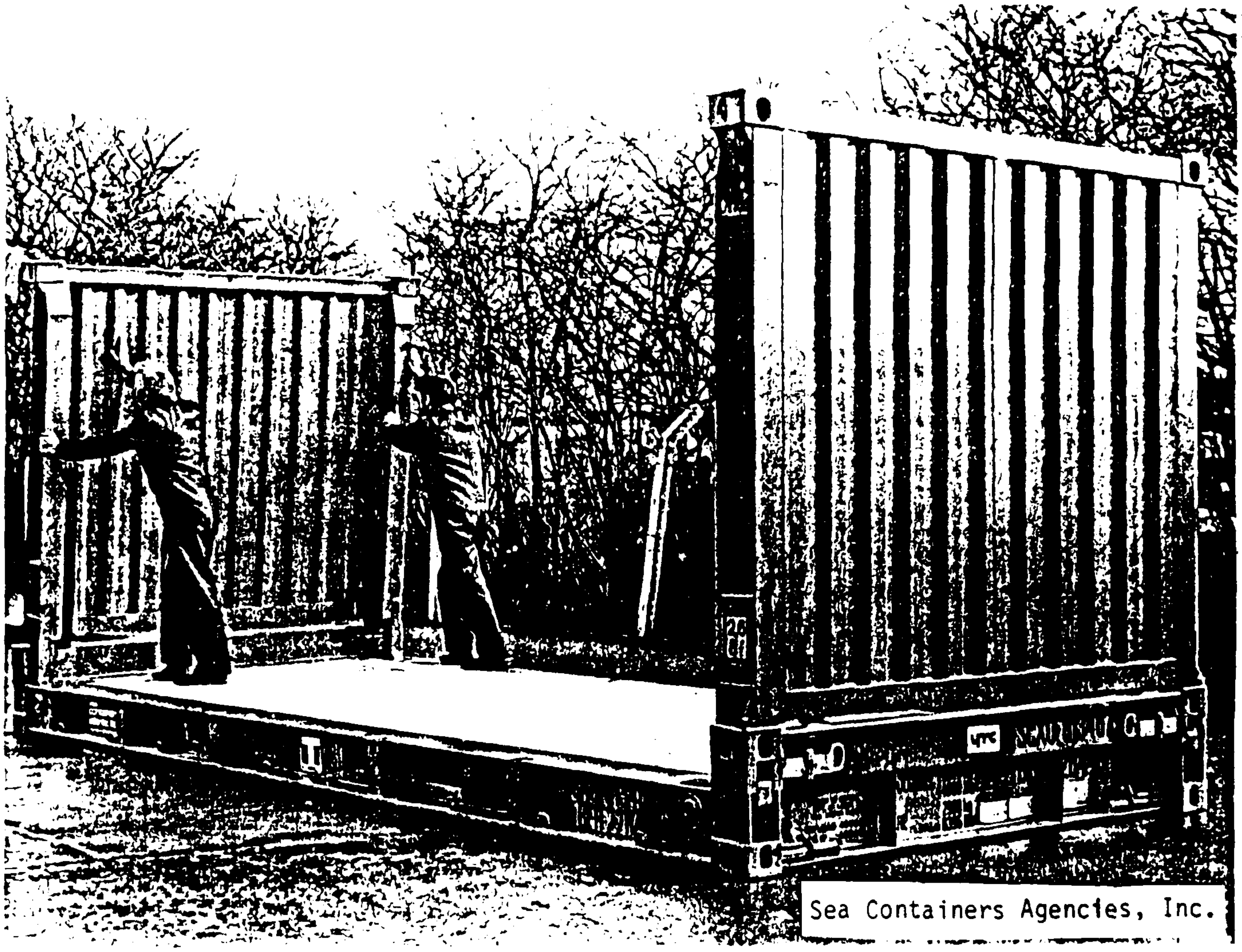
1. Designation: Commercial Seavan (Dry Van)
2. Dimensions (LxWxH):
   External: 20'x8'x8'6"; 20'x8'x8'
   Internal: 19'4"x7'8"x7'8.5"; 19'4"x7'8"x7'3"; 19'3"x7'6.5"x7'2.5"
3. Type Opening: Rear Door
   Dimensions (Internal WxH): 7'6"x7'6"
4. Weight in Pounds:
   Tare: 3,800 to 5,200 (Varies)
   Payload: 46,000 (Approx.)
5. Designed for Ammunition: No, General Cargo
6. Integral Restraint System: None
7. Restraint Required: Yes, Wooden Dunnage. Approved Procedures Fielded.
8. Used for Ammunition/Type: Yes/30MM, CBUs, Conventional Munitions, Small Arms
9. Availability: Inventory
10. US Flag Quantity: 777,275
11. Owner: Commercial
12. Special MHE: None
13. Has been tested and is satisfactory for ammunition use. USAF leased 30 from MSC for ammunition shipment to Pacific Air Forces and US Air Forces, Europe.
14. Data Source: USAF, DACS

PHOTOGRAPH NOT AVAILABLE

1. Designation: Special Dry Freight Box
2. Dimensions (LxWxH):
   External: 20'x8'x8'6"
   Internal: 19'4"x7'8"x7'9"
3. Type Opening: Full Side Doors
   Dimensions (Internal WxH): 18'3"x7'
4. Weight in Pounds:
   Tare: <5,800
   Payload: 52,000
5. Designed for Ammunition: No, but Redesigned
6. Integral Restraint System: High Strength Lashing Rings
7. Restraint Required: Cargo Straps
8. Used for Ammunition/Type: No
9. Availability: Projected-1986/Follow-on
10. US Flag Quantity: 300/693
11. Owner: Commercial
12. Special MHE: None
13. Manufacturers' contract award currently in process. Data shown apply to redesign of container for ammunition use. The container will be used for long term storage of all types of ammunition in a movement configuration.
14. Data Source: USAF, DACS



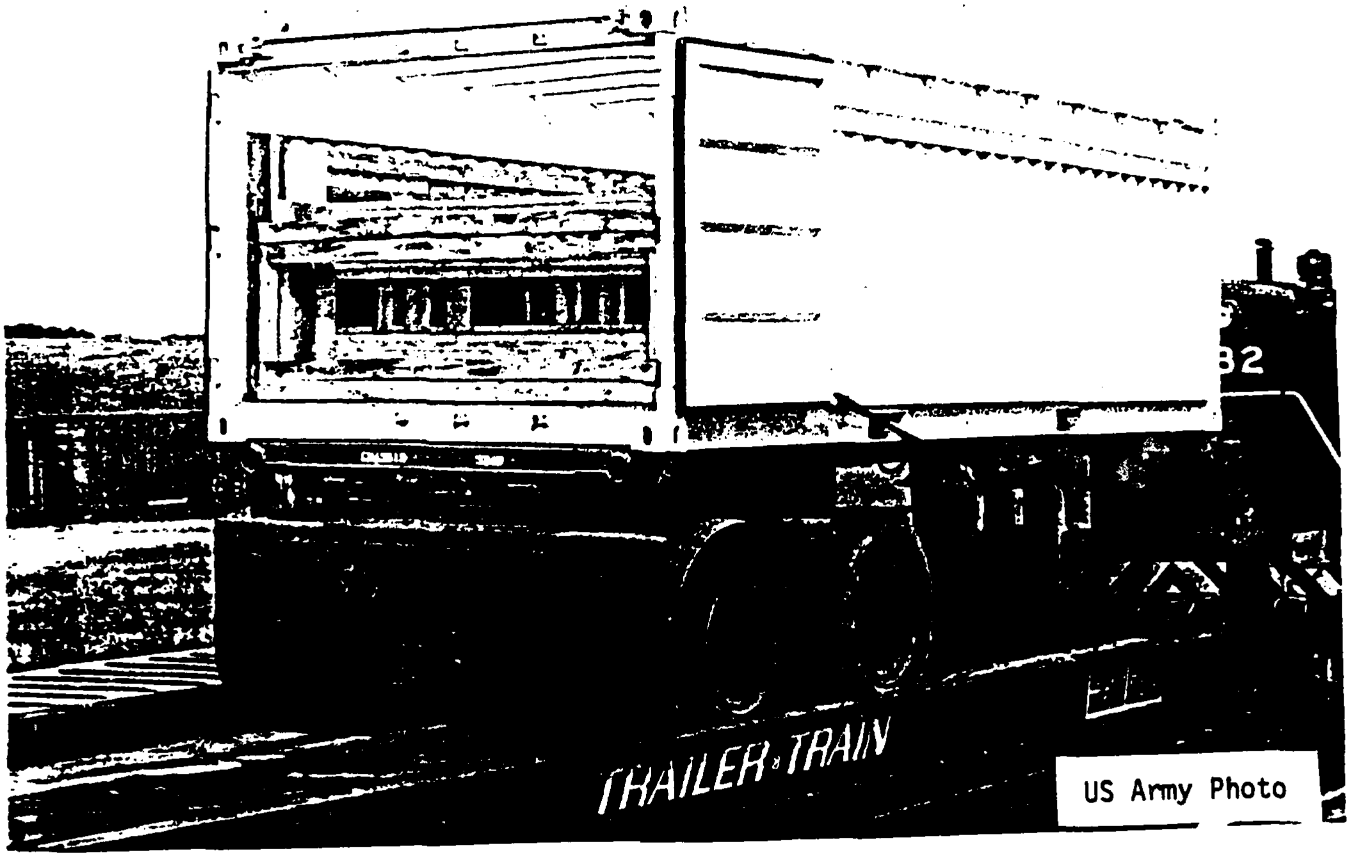
1. Designation: USAF Flatrack
2. Dimensions (LxWxH):
   External: Three Sizes-20'x8'x4'; 20'x8'x5'8"; 20'x8'x8'
   Internal: 19'4"x7'8"x3'4"; 19'4"x7'4"x4'9"; 19'4"x7'4"x7'
3. Type Opening: Full Access
4. Weight in Pounds:
   Tare: 6,085, 6,195
   Payload: 53,760
5. Designed for Ammunition: No, General Cargo
6. Integral Restraint System: Posts and Side Rails
7. Restraint Required: Steel Straps and Wooden Dunnage
8. Used for Ammunition/Type: Yes/30MM
9. Availability: Inventory
10. US Flag Quantity: 2,each size (6 total)
11. Owner: US Air Force
12. Special MHE: None
13. Commercial version is ammunition compatible. Coast Guard and DOT approved.
14. Data Source: USAF, DACS



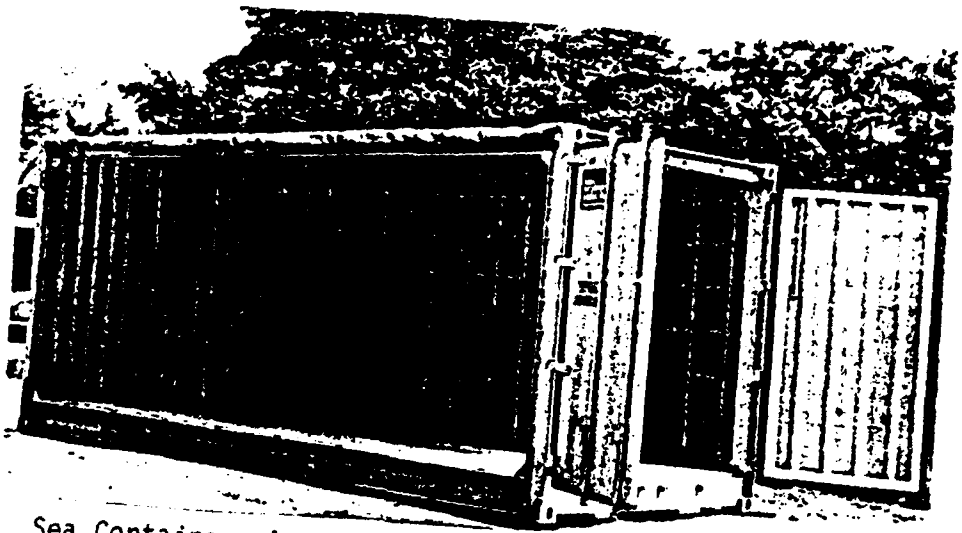
Sea Containers Agencies, Inc.

1. Designation: Collapsible Flatrack
2. Dimensions (LxWxH):
   External: 20'x8'x8'
   Internal: 19'5"x7'4"x7'; 19'5"x7'4"x7'7" (Varies)
3. Type Opening: Side Access
4. Weight in Pounds:
   Tare: 6,393
   Payload: 49,607
5. Designed for Ammunition: No, Machinery, Cable Drums, Timber, etc.
6. Integral Restraint System: Wood Flooring, Stake Pockets and 10 Lashing Rings Per Side. 7,716 Pounds Pull Strength
7. Restraint Required: Yes, Additional Lashing Rings, Steel Straps and Wooden Dunnage
8. Used for Ammunition Type: Trial Shipment
9. Availability: Inventory
10. US Flag Quantity: [illegible] (Includes Fixed End Flatrack)
11. Owner: Commercial
12. Special MHE: None
13. Data Source: [illegible]

1. Designation: Commercial Flatrack, Fixed End
2. Dimensions (LxWxH):
   External: 20'x8'x8'
   Internal: 19'6"x7'5"x7'7"
3. Type Opening: Side Access
4. Weight in Pounds:
   Tare: 6,170
   Payload: 46,000 (Approx)
5. Designed for Ammunition: No, Heavy and Bulky Items
6. Integral Restraint System: Wood Floor, Lashing Rings and Stake Pockets
7. Restraint Required: Yes, Blocking and Bracing
8. Used for Ammunition/Type: Yes/30MM in ALS Containers
9. Availability: Inventory
10. US Flag Quantity: 13,749 (Includes Collapsible Flatrack)
11. Owner: Commercial
12. Special MHE: None
13. Has been tested and is satisfactory for ammunition. USAF leased 36 from MSC for ammunition shipment to US Pacific Air Forces.
14. Data Source: USAF, DACS



1. Designation: Half Height Open Top
2. Dimensions (LxWxH):
   External: 20'x8'x4'3"
   Internal: 19'1"x7'7"x2'11"
3. Type Opening: Rear Drop End and Open Top with Tarpaulin
   Dimensions (Internal WxH): 7'6"x3' and Full Access (Top)
4. Weight in Pounds:
   Tare: 4,400
   Payload: 44,800
5. Designed for Ammunition: No, Dense Cargo, Ingots, Pipes, Metal, Waste, etc.
6. Integral Restraint System: Yes, but Inadequate. Only 12 Lashing Points with 3,310 Pound Pull Strength
7. Restraint Required: Yes, More and Stronger Lashing Points in Wooden Floor Version or Wooden Dunnage System
8. Used for Ammunition/Type: Yes, MPS
9. Availability: Inventory
10. US Flag Quantity: 2,187
11. Owner: Commercial and USMC on MPS
12. Special MHE: None
13. Currently in use by USMC in MPS
14. Data Source: USMC, DACS, USAF



Sea Containers Agencies, Inc.

1. Designation: Produce Carrier
2. Dimensions (LxWxH):
   External: 20'x3'x8'6"
   Internal: 19'4"x7'6"x7'5"
3. Type Opening: Dual- Rear Door and Sides (Grills and Tarpaulins)
   Dimensions (Internal WxH): 7'6"x7' and 18'8"x6'10"
4. Weight in Pounds:
   Tare: 6,945
   Payload: 49,055
5. Designed for Ammunition: No, Produce
6. Integral Restraint System: Inadequate, Only 5 Lashing Rings per Side. 4,480 Pound Pull Strength
7. Restraint Required: Yes, More Lashing Points or Adequate Side Grills and Rails
8. Used for Ammunition/Type: Test Only
9. Availability: Inventory
10. US Flag Quantity: 409
11. Owner: Commercial
12. Special MHE: None
13. Data Source: USAF, DACS

PHOTOGRAPH NOT AVAILABLE

1. Designation: Side Opening
2. Dimensions (LxWxH):
   External: 20'x8'x8'6"
   Internal: 19'5"x7'8"x7'11" (Varies)
3. Type Opening: Dual, Rear and Side(Dimensions not Provided)
4. Weight in Pounds:
   Tare: 5,500 (Approx.)
   Payload: 52,000 (Approx.)
5. Designed for Ammunition: No, General Cargo
6. Integral Restraint System: None
7. Restraint Required: Yes, to be Evaluated
8. Used for Ammunition/Type: No/Will Test
9. Availability: Projected
10. US Flag Quantity: 10
11. Owner: Commercial
12. Special MHE: None
13. USAF will develop and DACS will safety test an internal restraint system.
14. Data Source: USAF, DACS

END
DATE
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